AR TARGET SHEET

The following document was too large to scan as one unit, therefore, it has been divided into sections.

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TITLE:	Feasibility Study for 200-CS-1 Chemical Sewer Group OU DOE/RL-2005-63 Draft B Reissue and Proposed Plan for 200-CS-1 Chemical Sewer Group OU DOE/RL-2005-64 Draft B Reissue

4.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIATION GOALS

The primary objective of the FS is to develop and fully analyze an appropriate range of waste-management options that will protect human health and the environment. Appropriate waste management options that ensure the protection of human health and the environment may involve, depending on site-specific circumstances, the complete elimination or destruction of hazardous substances at the site, the reduction of concentrations of hazardous substances to acceptable health-based levels, prevention of exposure to hazardous substances via engineering or institutional controls, or some combination of the above (EPA/540/G-89/004). The FS process consists of three major components:

1. Development of alternatives
2. Evaluation of the alternatives
3. Detailed analysis of alternatives.

Chapter 4.0 addresses the development of RAOs and general-response actions, and identifies the volumes or areas of media to which general-response actions might be applied (first major component of the FS process). Chapter 5.0 identifies and compares remedial technologies and process options. Chapter 6.0 groups the remedial technologies and process options into remedial-action alternatives and describes those alternatives. Chapter 7.0 provides a detailed analysis of the remedial-action alternatives using the CERCLA evaluation criteria (last major component of the FS process). Chapter 8.0 compares the remedial-action alternatives for the 200-CS-1 OU waste sites.

4.1 INTRODUCTION

This section addresses development of RAOs and general-response actions and identifies volumes of contaminated media. Chapter 4.0 is organized into subsections as follows:

- 4.2 Purpose and Objectives
- 4.3 Land-Use and Nature and Extent of Contamination
- 4.4 Development of Remedial Action Objectives
- 4.5 Development of General Response Actions

Previous sections of this FS present the results of investigations into the nature and extent of contamination at the 200-CS-1 OU waste sites and an assessment of the baseline risks to human health and the environment from the contamination. Chapter 3.0 evaluates the risks from exposure to contaminated soil by completing a human-health risk assessment and a SLERA and evaluates potential impacts of soil contamination to groundwater. These analyses determined that soils at the 200-CS-1 OU waste sites pose unacceptable risks and require an FS to develop and assess remedial-action alternatives. The revised BRA presented in Chapter 3.0 also concluded that there are biases and uncertainties associated with the degree and extent of contamination and subsequent risks. However, the strategy employed at these 200-CS-1 OU waste sites was that "*Prior to beginning remediation, confirmation sampling will be performed to ensure that sufficient characterization data are available to confirm that the* *selected remedy is appropriate for all waste sites within the OU, to collect data necessary for the remedial design, and to support future risk assessments, if needed"* (DOE/RL-99-44).

4.2 PURPOSE AND OBJECTIVES

The purpose of this FS is to develop and provide to decision-makers a range of response actions that will protect human health and the environment, particularly groundwater near these waste sites, from the contamination associated with the 200-CS-1 OU waste sites. The objectives of this FS are the following:

1. Further refine the RAOs preliminarily identified in DOE/RL-98-28 and DOE/RL-99-44, based on the results of the revised BRA. The RAOs specify the contaminants and media of concern, exposure pathways, receptors, and PRGs that permit a range of treatment and containment alternatives to be developed

2. Further refine chemical-, location-, and action-specific ARARs and criteria to be considered

3. Identify general-response actions for each medium (soil and groundwater) that may meet RAOs, either individually or in combination with other general-response actions

4. Identify, compare, and evaluate remedial technology types for each general-response action, based on technical implementability

5. Evaluate process options that pass the preliminary comparison based on effectiveness, implementability, and relative cost to select one or more representative process options for each technology type

6. Assemble representative process options into a range of remedial alternatives, from limited action (including ICs) to containment, removal, and treatment alternatives

7. Perform a detailed analysis of potential remedial alternatives to address the COCs using the two CERCLA threshold criteria of protection of human health and the environment and ability to meet ARARs; and the five CERCLA balancing criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost)

8. Perform a comparative analysis of the remedial alternatives using the seven threshold and balancing criteria to determine the relative performance of each alternative in relation to specific evaluation criterion, which identifies the advantages and disadvantages of each alternative relative to one another and the key tradeoffs.

Two additional modifying criteria, State of Washington acceptance and community acceptance, will be evaluated following comment on this FS report and the proposed plan, and will be addressed in the ROD.

4.3 LAND USE AND NATURE AND EXTENT OF CONTAMINATION

To identify appropriate cleanup objectives, the future land use of a site must be considered. Current and future land uses of the 200 Areas and the Central Plateau are discussed in the following sections.

4.3.1 Current Land Use

All current land-use activities associated with the 200 Areas and the Central Plateau are industrial in nature. The facilities located in the Central Plateau were built to process irradiated fuel from the plutonium production reactors in the 100 Areas. Most of the facilities directly associated with fuel reprocessing are now inactive and awaiting final disposition. Several waste-management facilities operate in the 200 Areas, including permanent waste disposal facilities such as the Environmental Restoration Disposal Facility, low-level radioactive-waste burial grounds, and a RCRA-permitted mixed-waste trench. Construction of tank-waste treatment facilities in the 200 Areas began in 2002, and the 200 Areas are the planned disposal location for the vitrified low-activity tank wastes. Past-practice disposal sites in the 200 Areas are being evaluated for remediation and are likely to include ICs (e.g., deed restrictions or covenants) as part of the selected remedy. Other Federal agencies, such as the U.S. Department of the Navy, also use the Hanford Site 200 Areas nuclear-waste TSD facilities. A commercial low-level radioactive-waste disposal facility, operated by U.S. Ecology, Inc., currently operates on a portion of a tract in the 200 Areas that is leased to the State of Washington.

DOE-selected land uses for the areas associated with the 200-CS-1 OU waste sites, documented through the land-use ROD (64 FR 61615) and environmental impact statement (DOE/EIS-0222-F) are industrial (exclusive) for sites located within the exclusive-use boundary and are conservation (mining) for sites outside the boundary. Consistent with Tri-Party Response to HAB Advice #132, for the purposes of this FS, all of the waste sites associated with the 200-CS-1 OU are located in the core zone and are to be considered industrial (exclusive) land-use.

According to DOE/EIS-0222-F, industrial (exclusive) land use would preserve DOE control of the continuing remediation activities and would use the existing compatible infrastructure required to support activities such as dangerous-waste, radioactive-waste, and mixed-waste TSD facilities. The DOE and its contractors, and the U.S. Department of Defense and its contractors, could continue their Federal waste-disposal missions; and the Northwest Low-Level Radioactive Waste Compact could continue using the U.S. Ecology, Inc., site for commercial radioactive waste. Research supporting the dangerous-waste, radioactive-waste, and mixed-waste TSD facilities also would be encouraged within this land-use designation. New uses of radioactive materials such as food irradiation could be developed, and the products could be packaged for commercial distribution here under this land-use designation.

The conservation (mining) land use would enable the extraction of valuable near-surface geologic resources to support implementation of remedial actions (i.e., surface barriers) at some locations on the Hanford Site after obtaining *National Environmental Policy Act of 1969* (NEPA) or CERCLA approval to protect NEPA-sensitive (e.g., biologic, geologic, historic, or cultural) resources. The Hanford Site has no proven reserve of any metallic ore bodies; therefore, heap/leach or open-pit mining methods would not be applicable. In addition, DOE/EIS-0222-F indicates that a notice of deed restriction would be placed in those areas where vadose-zone contamination remained in place, according to a CERCLA, ROD, or RCRA closure permit, foreclosing the mining option. DOE/EIS-0222-F anticipates mining only for materials needed to build surface barriers as part of remedial actions and that mining would be precluded from contaminated areas. The conservation (mining) land use would afford protection of natural resources; however, other compatible uses, such as recreation or nonintrusive environmental research activities, also would be allowed, provided these activities are consistent with the purpose of the conservation land-use designation. Conservation would require active management practices to enhance or maintain the existing resources and to minimize or eliminate undesirable or nonnative species.

The ROD (64 FR 61615) identifies conservation (mining) as an area reserved for the management and protection of archeological, cultural, ecological, and natural resources. Limited and managed mining (e.g., quarrying for sand, gravel, basalt, and topsoil for governmental purposes only) could occur as a special use (i.e., a permit [issued by the DOE Realty Officer] would be required) within appropriate areas. Limited public access would be consistent with resource conservation. The ROD also indicates that mining would be restricted from contaminated areas.

4.3.2 Anticipated Future Land Use

The reasonable anticipated future land use for the areas associated with the 200-CS-1 OU waste sites is continued industrial activities. The DOE worked for several years with cooperating agencies and stakeholders to define land-use goals for the Hanford Site and develop future land-use plans (Drummond 1992). The cooperating agencies and stakeholders included the U.S. Department of the Interior, Tribal Nations, States of Washington and Oregon, local county and city governments, economic and business development interests, environmental groups, and agricultural interests. These activities initially were reported by Drummond (1992) and culminated in DOE/EIS-0222-F and the associated ROD (64 FR 61615), which were issued in 1999 to address future land use through 2049.

DOE/EIS-0222-F was written to address the growing need for a comprehensive, long-term approach to planning and development on the Hanford Site because of the DOE's separate missions of environmental restoration, waste management, and science and technology. DOE/EIS-0222-F analyzes the potential environmental impacts of alternative land-use plans for the Hanford Site and considers the land-use implication of ongoing and proposed activities. In DOE/EIS-0222-F, the land-use designation for the site is as follows:

- Industrial (Exclusive) – Areas suitable and desirable for TSD of hazardous, dangerous, radioactive, and nonradioactive wastes, and related activities.

Under the preferred land-use alternative selected in the ROD (64 FR 61615), the area within the exclusive-use boundary of the Central Plateau is designated for industrial (exclusive) use. The current vision for all of the 200 Areas is that it will continue through 2049 to be used for the TSD of hazardous, dangerous, radioactive, and nonradioactive wastes. DOE/EIS-0222-F and the ROD incorporate this vision in their selected alternative, describe the means by which new projects will be sited, and focus on using existing infrastructure and developed areas of the Hanford Site for new projects. To support the current vision, the 200 Areas projects will maintain current facilities for continuing missions, remediate soil waste sites and groundwater to support industrial land uses, lease facilities for waste disposal (such as to U.S. Ecology, Inc.), and demolish facilities that have no further beneficial use. Based on DOE/EIS-0222-F and the associated ROD, and consistent with other Hanford Site waste-management decisions, this FS report assumes industrial land use for all of the waste sites.

4.3.3 Regional Land Use

Communities in the region of the Hanford Site consist of the incorporated cities of Richland, West Richland, Kennewick, and Pasco, as well as surrounding communities within Benton and Franklin Counties. The estimated population of the region in the year 2000 was 186,600, with the population of Benton County being 140,700 and the population of Franklin County being 45,900. There are no residences on the Hanford Site. The nearest inhabited residences to the 200 Areas are farmhouses on land approximately 16 km (10 mi) north across the Columbia River. The City of Richland corporate boundary is approximately 27 km (17 mi) to the south (PNNL-6415).

4.3.4 Land-Use Summary

Drummond (1992) identified a single cleanup scenario for the Central Plateau. This scenario assumes that future uses of the surface, subsurface, and groundwater in and immediately surrounding the 200 East and 200 West Areas will be "exclusive." Consistent with Drummond (1992), the exclusive-use area, which includes the 200 East and 200 West Areas, has been designated as industrial in DOE/EIS-0222-F. All of the 200-CS-1 OU waste sites are located within this exclusive-use area.

By Presidential proclamation, an area surrounding the Central Plateau was designated as the Hanford Reach National Monument, an area set aside by the Federal government to be protected because of its unique and diverse ecological and cultural resources. In a memorandum from the President of the United States to the Secretary of Energy, dated June 9, 2000, the President directed the Secretary to protect these important assets where practical on the Central Plateau (Clinton, 2000, *Hanford Reach National Monument*).

4.3.5 Nature and Extent of Soil Contamination

An investigation into the nature and extent of contamination was performed for each 200-CS-1 OU waste site, and the results are summarized in Sections 4.3.5.2 through 4.3.5.5

below. The details of the risk assessment were discussed in Chapter 3.0. Section 3.7 summarized the risk assessment and the COCs and COECs identified after following the risk assessment methods outlined in Figures 3-4 through 3-6. These COCs and COECs were further evaluated for their implications to the FS and summarized as risk drivers in Table 3-14. These risk drivers are the basis for the discussion and evaluation in Chapters 4.0 through 8.0. Risk drivers are COCs and COECs and are often referred to as such in Chapters 4.0 through 8.0.

4.3.5.1 Exposure-Pathway Model

An exposure pathway is the means by which a contaminant moves from a source to a receptor (a potentially exposed individual or organism). A complete exposure pathway has the following five elements:

- A contaminant source
- A mechanism for contaminant release
- An environmental-transport medium
- An exposure point (i.e., a location where people or wildlife can come into contact with the contaminants)
- A feasible route of exposure (ingestion, dermal contact, direct exposure, or inhalation).

Figures 3-1 and 3-2 depict the complete human- and ecological-receptor exposure pathways from the conceptual site models described in the revised BRA. An exposure pathway is complete if a means is available for the receptor to be exposed through ingestion, inhalation, direct exposure, or dermal absorption at a location where site-related contaminants are present. No exposure (and therefore no risk) exists unless the exposure pathway is complete.

Evaluation of complete exposure pathways is a key feature in the RI/FS and risk assessment process. This information also is used in the FS to evaluate remedial action by considering pathway modifications (e.g., contaminant sources, releases, transport, and exposure) through the use of technologies and ICs.

4.3.5.2 Summary of Human-Health Risk Assessment

A human-health risk assessment was performed as indicated in the Work Plan (DOE/RL-99-44) and is presented in Section 3.4. No unacceptable human-health risks for an industrial scenario were identified in the revised BRA. The revised BRA determined that the soil in the 200-CS-1 OU waste sites poses an acceptable risk to human health, albeit with uncertainty, as discussed in Sections 3.4 and 3.7. In addition to the BRA, an analysis was completed to examine the need for ICs. RESRAD was used to evaluate potential doses greater than 15 mrem/y at each waste site without the current cover. This evaluation was used if the human health, SLERA, and groundwater-protection pathway did not result in any risk drivers. This additional evaluation can be found in Appendix E. The 216-B-63 Trench and the 216-S-10 Pond were the two wastes sites where no risk drivers were identified. The additional analysis showed that the 216-B-63 Trench would result in doses exceeding 15 mrem/y if the cover at that waste site was removed or eroded away, while the 216-S-10 Pond did not.

4.3.5.3 Summary of Ecological Risk Assessment

A SLERA was performed in Section 3.5. Maximum concentrations of nonradionuclides at the 200-CS-1 OU waste sites pose unacceptable risks to ecological receptors from exposure to soils and/or debris contaminated with nonradiological constituents at concentrations above the industrial land-use criteria, as defined in WAC 173-340-7493, for ecological receptors. The methodology for the radionuclide ecological evaluation follows the process developed by DOE in DOE-STD-1153-2002. The COECs identified in the SLERA (and discussed in Section 3.7) are summarized in Table 3-14. The SLERA found that both radiological and nonradiological constituents posed a potential threat to ecological receptors for the 216-A-29 Ditch. At the 216-S-10 Ditch, the SLERA found that only nonradiological constituents posed a potential threat to ecological receptors.

4.3.5.4 Summary of Groundwater-Protection Pathway Evaluation

A groundwater-protection pathway analysis was completed in Section 3.6. For the groundwater-protection pathway, the aquifer is the point of compliance, and the entire vadose zone (from ground surface to groundwater) is considered when evaluating possible impacts to the groundwater. Nonradionuclides were evaluated through a comparison of maximum waste-site concentrations to the WAC 173-340-747 groundwater protection CULs. Radionuclides were assessed through a model of the site developed using the RESRAD code for radionuclides. The revised BRA found a number of COCs summarized in Table 3-14. Nonradiological constituents at the 216-A-29 Ditch waste site potentially posed a potential threat to groundwater. At the 216-S-10 Ditch, the revised BRA also found that only nonradiological constituents posed a potential threat to groundwater. Although these soils (viewed as the contaminant source to groundwater) will be addressed in this FS, contaminated groundwater will be addressed by the 200-BP-5, 200-PO-1, 200-UP-1, and 200-ZP-1 Groundwater OUs.

4.3.5.5 Volumes of Contaminated Media

Based on the risk-assessment results in Chapter 3.0, the following descriptions and nomenclature will be used to discuss the various waste sites throughout the remainder of the FS.

- Waste Site 216-A-29 Ditch has two segments, and Figure 4-1 shows the location of each segment. Segment 1 is the portion of the 216-A-29 Ditch that is between Test Pits AD-2 and AD-3. Segment 2 is the part of the 216-A-29 Ditch that is between Test Pits Area AD-1 and AD-3.

- Waste Sites 216-B-63 Trench and 216-S-10 and 216-S-11 Ponds will not be segmented and will be addressed as separate sites.

- Waste Site 216-S-10 Ditch has three segments, and Figure 4-2 shows the locations of these segments. These segments include the covered portion of the ditch from Test Pit SP-1 to Test Pit SD-1, the uncovered Segment 1, which extends from Test Pit SD-1 to Test Pit SD-3, and the uncovered Segment 2, which extends from Test Pit SD-3 to Test Pit SD-2.

Table 4-1 summarizes the volumes of contaminated soil by waste site, based on the risks identified in the revised BRA. Although there are uncertainties associated with the risk assessment (see Sections 3.4, 3.5, 3.6, and 3.7), estimated volumes range from 1,750 m^3 (2,300 yd^3) for Segment 2 of the 216-A-29 Ditch to 2,450 m^3 (3,200 yd^3) for the uncovered portion of Segment 2 of the 216-S-10 Ditch. The risk assessment results indicate that there is no unacceptable risk in the soil at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds, based on current conditions (i.e., soil cover).

4.4 DEVELOPMENT OF REMEDIAL-ACTION OBJECTIVES

This section includes a discussion of COCs, RAOs, and PRGs. RAOs consist of medium-specific or OU-specific goals for protecting human health and the environment, including protection of groundwater. The objectives should be as specific as possible, but not so specific that the range of alternatives that can be developed is unduly limited. RAOs aimed at protecting human health and the environment should specify the following (EPA/540/G-89/004):

- The COCs
- The exposure route(s) and receptor(s)
- An acceptable contaminant level or range of levels for each exposure route (i.e., a PRG).

4.4.1 Introduction

RAOs for the 200-CS-1 OU FS are developed in this section. Inputs to developing the RAOs include the conceptual site model, the results of the BRA, and significant chemical-specific ARARs. The resulting RAOs are word statements that specify the media, COCs, potential exposure routes, and PRGs to protect human health and the environment and ensure that the site complies with ARARs.

RAOs are used throughout the FS process, first to aid in identifying technologies and, later, as a basis for evaluating their effectiveness. The objectives for protection of human health and the environment can be achieved by the elimination or destruction of hazardous substances at the site, eliminating exposure routes, and/or reducing contaminant concentrations. In the 200-CS-1 OU revised BRA's evaluation of exposure routes, the industrial-worker scenario was considered based on current and future land use.

As shown in Figures 3-1 and 3-2, human- and ecological-exposure pathways are associated with shallow-zone soils defined as those soils extending from the ground surface to a depth of 4.6 m (15 ft) bgs. In the human and ecological risk assessments presented, potential exposure concentrations at each site are represented by the maximum detected concentration in the 0 to 4.6 m (0 to 15 ft) soil column, referred to as "shallow-zone soil."

The process of developing specific RAOs and PRGs for the 200-CS-1 OU is presented in the following steps:

- Develop RAOs for the soil and groundwater pathway
- Develop general-response actions
- Develop specific PRGs for 200-CS-1 OU COCs, based on the RAOs and chemical-specific ARARs.

4.4.2 Remedial-Action Objectives

Following are the RAOs to be used for the Central Plateau waste sites.

- RAO 1 – Prevent unacceptable risk to human health and ecological receptors from exposure to soils and/or debris contaminated with nonradiological constituents at concentrations above the industrial-use criteria, as defined in WAC 173-340-745(5)(b) ("Soil Cleanup Standards for Industrial Properties," "Method C Industrial Soil Cleanup Levels," "Standard Method C Industrial Soil Cleanup Levels") for human health, or the evaluation criteria in WAC 173-340-7493 for ecological receptors.
- RAO 2 – Prevent unacceptable risk to human health and ecological receptors from exposure to soils and/or debris contaminated with radiological constituents by:
  - Preventing exposure to radiological constituents at concentrations that will cause a dose rate limit of 15 mrem/y above background for industrial workers (EPA/540/R-97/006). A dose-rate limit of 15 mrem/y above background generally achieves the EPA excess lifetime cancer risk threshold, which ranges from 10^{-6} to 10^{-4}.
  - Protecting ecological receptors based on a dose-rate limit of 1.0 rad/d for aquatic animals and terrestrial plants and 0.1 rad/d for terrestrial animals (DOE-STD-1153-2002), which is a "to-be-considered" criterion.
- RAO 3 – Prevent migration of nonradiological hazardous chemicals through the soil column to groundwater, or reduce soil concentrations below WAC 173-340-747 groundwater protection criteria, so that no further degradation of the groundwater results from contaminants leaching from the soil.

- RAO 4 – Prevent migration of radioactive contaminants from the soil column to groundwater based on protection criteria in 40 CFR 141.66 "Maximum Contaminant Levels for Radionuclides," so that no further degradation of the groundwater results from contaminants leaching from the soil.
- RAO 5 – Prevent adverse impacts to cultural resources and threatened or endangered species, and minimize wildlife habitat disruption.
- RAO 6 – Prevent or reduce occupational health risks to workers performing remedial actions.
- RAO 7 – Ensure that appropriate ICs and monitoring requirements are established to protect future users of the remediated waste sites.

Achievement of Remedial Action Objective 1

For carcinogenic chemicals, RAO 1 will be achieved by prevention or reduction of human-health carcinogenic risks from waste or contaminated soil. RAO 1 will be achieved when the *Washington Administrative Code* and CERCLA excess lifetime cancer risk is not greater than the goal of 10^{-5}, using industrial exposure assumptions and the equations in WAC 173-340-745(5)(b).

For noncarcinogenic chemicals, RAO 1 is defined as prevention or reduction of risks from direct contact with waste or contaminated soils that are greater than a hazard quotient of one, using industrial-exposure assumptions and the equations in WAC 173-340-745(5)(b).

Exposure of ecological receptors to wastes or soil contaminated with nonradiological constituents will be prevented or reduced with exceedances factors of less than one, using industrial-exposure assumptions and calculations in WAC 173-340-7493.

Achievement of Remedial Action Objective 2

RAO 2 will be considered achieved when DOE site workers' dose rates are not greater than 500 mrem/y for the next 50 years, and for industrial workers when dose rates caused by exposure to waste or contaminated soil are not greater than 15 mrem/y above background (generally equal to the EPA excess lifetime cancer risk of 10^{-4} to 10^{-6}) for the period from 50 to 1,000 years from the present. In addition, RAO 2 is achieved when remaining waste is located below the point of compliance (4.6 m [15 ft] bgs). For ecological receptors, exposure to wastes or soil contaminated with radionuclides will be prevented or reduced such that dose rates are not greater than 0.1 rad/d for terrestrial animals and 1.0 rad/d for aquatic animals and terrestrial plants.

Achievement of Remedial Action Objective 3

RAO 3 prevents further degradation of groundwater by hazardous chemical contamination. RAO 3 is achieved by preventing or reducing migration of contaminants through the soil column to groundwater such that concentrations reaching groundwater are not greater than the maximum contaminant levels under 40 CFR 141, "National Primary Drinking Water Regulations," and/or State of Washington drinking water standards (WAC 246-290, "Public Water Supplies" and WAC 173-340-720, "Ground Water Cleanup Standards").

Achievement of Remedial Action Objective 4

RAO 4 prevents further degradation of groundwater by radionuclide contamination. RAO 4 is achieved by preventing or reducing migration of contaminants through the soil column to groundwater, such that concentrations reaching groundwater are not greater than the maximum contaminant levels under 40 CFR 141.66.

Achievement of Remedial Action Objective 5

RAO 5 is achieved by implementing existing Hanford Site standards for protection of cultural resources and wildlife habitat and by enforcing appropriate ICs and monitoring requirements. The DOE has integrated natural-resource concerns into Hanford Site FSs in accordance with DOE policies.

Achievement of Remedial Action Objective 6

RAO 6 will be achieved by meeting RAOs 1 and 2, implementing existing Hanford Site standards for protection of industrial workers, and continuing to implement existing ICs and monitoring requirements.

Achievement of Remedial Action Objective 7

RAO 7 is achieved by implementing the appropriate ICs and monitoring requirements that are identified in the ROD (64 FR 61615) and OU-specific operations and maintenance plans completed by Fluor Hanford, Inc. The ICs are identified in the Sitewide IC plan (DOE/RL-2001-41).

Based on the human-health, ecological, and groundwater-protection pathway risks presented in Table 3-14, the specific RAOs for the 200-CS-1 OU by waste site are as follows.

216-A-29 Ditch

- RAO 1 – Prevent unacceptable risk to ecological receptors from exposure to soils and/or debris contaminated with nonradiological constituents listed in Table 3-14.
- RAO 2 – Prevent unacceptable risk to ecological receptors from exposure to soils and/or debris contaminated with radiological constituents listed in Table 3-14.
- RAO 3 – Prevent migration of nonradiological hazardous chemical contaminants listed in Table 3-14 through the soil column to groundwater.

216-B-63 Trench

- RAO 2 – Prevent unacceptable dose to DOE site workers (if the current cover were to be removed) from exposure to soils contaminated with radiological constituents discussed in Section 3.4 and Appendix E.

216-S-10 Ditch

- RAO 1 – Prevent unacceptable risk to ecological receptors from exposure to soils and/or debris contaminated with nonradiological constituents listed in Table 3-14.

- RAO 3 – Prevent migration of nonradiological hazardous chemical contaminants listed in Table 3-14 through the soil column to groundwater.

216-S-10 and 216-S-11 Ponds

- There are no RAOs for the 216-S-10 or 216-S-11 Ponds, because there are no unacceptable risks at these locations.

4.5 DEVELOPMENT OF GENERAL RESPONSE ACTIONS

The following general-response actions describe various remedial approaches that will satisfy the RAOs described above.

General-response actions are broad categories of remedial measures that produce similar results when implemented. The general-response actions evaluated for the 200-CS-1 OU include ICs, monitoring, containment, in situ treatment, removal, ex situ treatment, and disposal. The identified general-response actions may be implemented individually or in combination to meet the RAOs. The general-response actions are discussed further for each grouping and subgrouping identified in Section 5.2.

Formulation of a no-action alternative is required by 40 CFR 300.430(e)(6), "Remedial Investigation/Feasibility Study and Selection of Remedy" "Feasibility Study," "The No-Action Alternative." The no-action alternative serves as a baseline for evaluating other remedial-action alternatives and is retained throughout the FS process. No action implies that no remediation or any other actions will be implemented to alter or monitor the existing site conditions.

4.5.1 200-CS-1 Operable Unit Soils General-Response Actions

Seven general-response actions that may satisfy the RAOs for 200-CS-1 OU soils are discussed below.

Site Controls—ICs that function as site controls are described in the Sitewide IC plan (DOE/RL-2001-41). The volume, mobility, and toxicity of the COCs are not reduced other than through natural attenuation processes.

Monitoring—Monitoring alone would not reduce volume, mobility, or toxicity of the COCs, but could be used to determine the extent of contamination above PRGs, as part of a removal, containment, or in situ treatment remedy or to measure progress of a remedy toward PRGs. Either field (in situ) or laboratory analytical techniques or both could be used to determine soil concentrations of the COCs.

Containment—Containment isolates contaminated media from release mechanisms, transport pathways, and exposure routes using surface and/or subsurface barriers, thereby reducing or eliminating exposures to receptors. Containment alone does not reduce the volume or toxicity of the contaminants.

In Situ Treatment—In situ treatment reduces the toxicity, mobility, or volume of the COCs or contaminated media using physicochemical or biological technologies. Contaminant sources may be reduced or eliminated, and contaminant-migration pathways and exposure routes may be eliminated. The contaminated soil is treated in place, without excavation.

Removal—Removal technologies reduce or eliminate contaminant sources using conventional or other types of excavation and handling of contaminated soil. Removed soil subsequently is treated, stored, or disposed of.

Ex Situ Treatment—Based on sampling results to date, ex situ treatment of removed 200-CS-1 OU soil before it is disposed of is not required to meet the Environmental Restoration Disposal Facility waste-acceptance criteria. Therefore, ex situ treatment of 200-CS-1 OU soil is not considered further in this FS.

Disposal—Disposal involves placement of excavated material in an engineered permanent waste-management facility that serves to restrict contaminant mobility and mitigate exposure routes. The disposal option considered in this FS is the Environmental Restoration Disposal Facility.

4.5.2 Applicable or Relevant and Appropriate Requirements and Preliminary Remediation Goals

Appendix G identifies and evaluates potential ARARs for waste-site remediation in the 200-CS-1 OU. The chemical-specific ARARs likely to be most relevant to remediation of the 200-CS-1 OU are the elements of the State of Washington regulations that implement WAC 173-340, specifically those associated with developing risk-based concentrations for cleanup (WAC 173-340-745). The requirements of WAC 173-340-745 help establish soil cleanup standards for nonradioactive contaminants at waste sites. The requirements of WAC 173-340-7493 establish site-specific terrestrial ecological-evaluation procedures at waste sites. Table 4-2 provides the PRGs for the 200-CS-1 OU. The PRGs are based on the listed parts of WAC 173-340.

Figure 4-1. Locations of the 216-A-29 Ditch Segments.

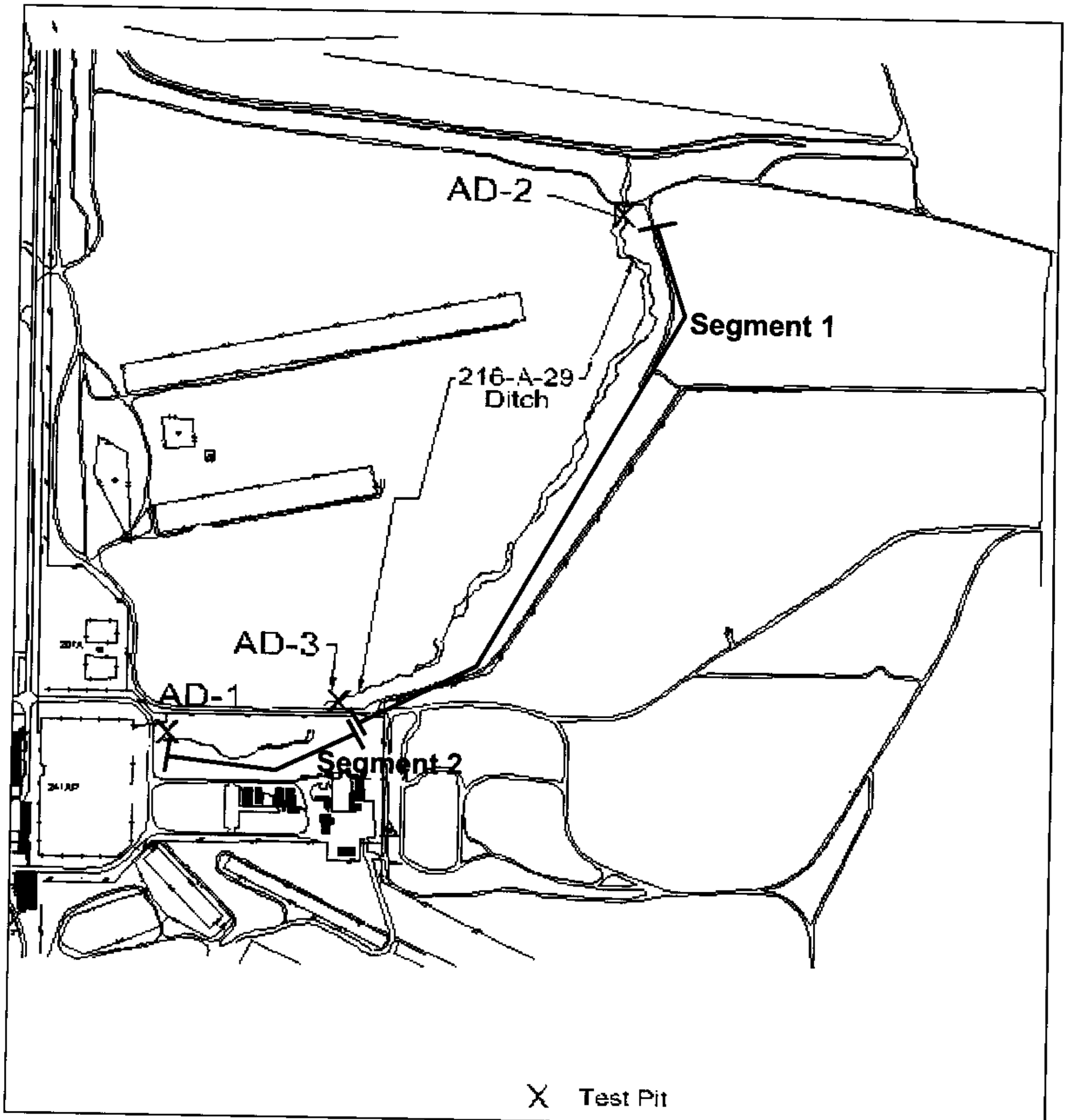

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Figure 4-2. Locations of the 216-S-10 Ditch Segments.

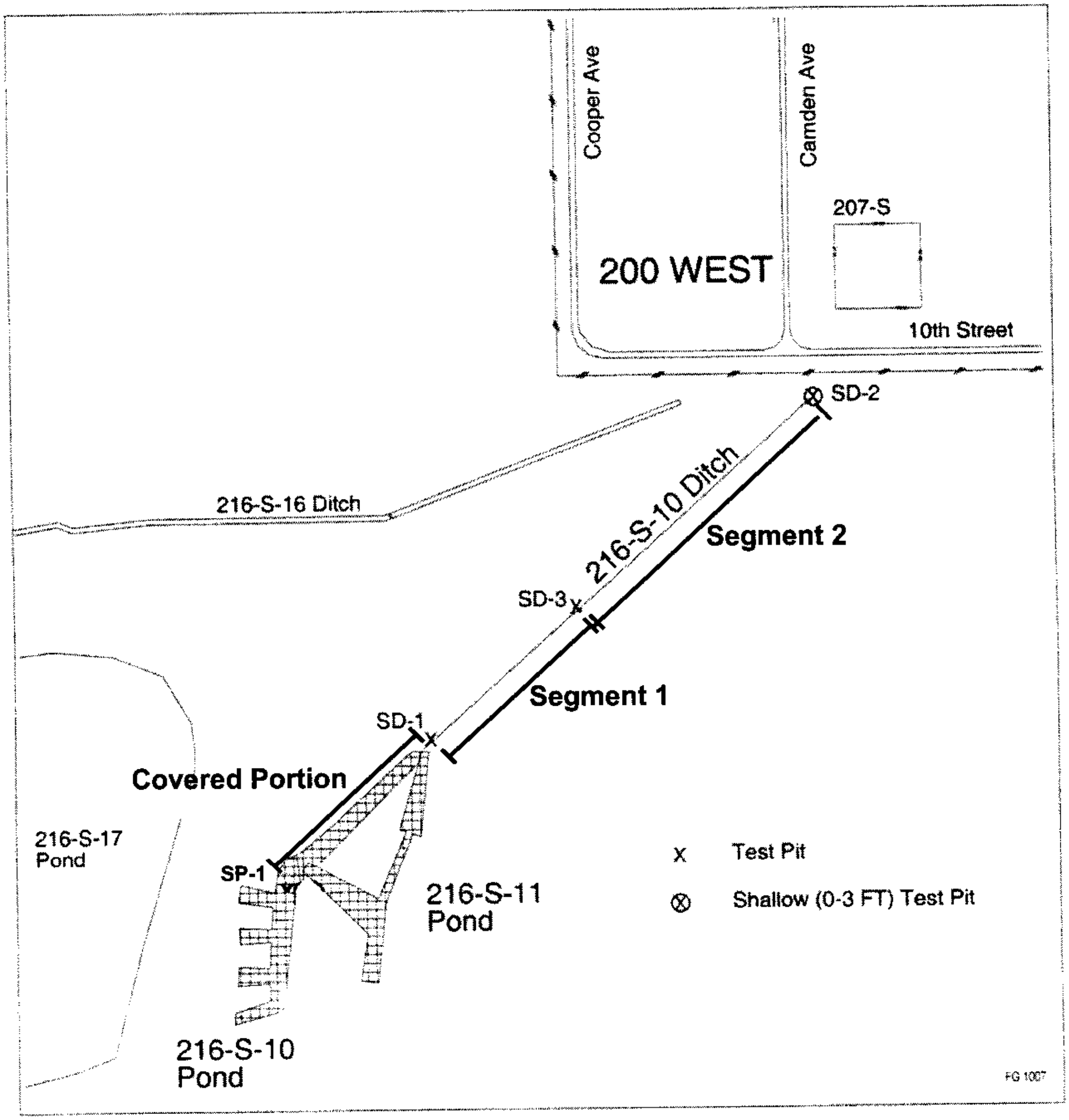

Table 4-1. Volumes of Contaminated Media.

Waste Site	Site Description	Constructed Dimensions					Contamination Depth from Risk Assessment (m [ft])	Contamination Volume (m^3 [yd^3]) (L x W x Depth)[1,2]
		Length (m [ft])	Width (m [ft])	Depth Below Ground Surface (m [ft])	Volume (m^3 [yd^3]) (L x W x Depth)[1,2]	Surface Area (m^2 [a.])[3]		
216-A-29	**Ditch**							
Segment 1	AD-2 to AD-3	1,500 [4,920]	1.83 [6]	2.59 [8.5]	7,110 [9,300]	2,745 [0.7]	0 [0]	0 [0]
Segment 2	AD-3 to AD-1	480 [1,580]	1.83 [6]	2.59 [8.5]	2,280 [3,000]	880 [0.2]	1.98 [6.5]	1,750 [2,300]
Total		1,980 [6,500]			9,390 [12,300]	3,625 [0.9]		1,750 [2,300]
216-B-63	**Trench**	427 [1,400]	1.22 [4]	3.05 [10]	1590 [2,100]	520 [0.13]	0 [0]	0 [0]
216-S-10	**Ditch**							
Backfilled/Covered Section	SP-1 to SD-1	180 [590]	1.83 [6]	1.83 [6]	610[800]	330 [0.08]	0 [0]	0 [0]
Uncovered Segment 1	SD-1 to SD-3	210 [690]	1.83 [6]	3.05 [10]	1,180 [1,600]	390 [0.1]	0 [0]	0 [0]
Uncovered Segment 2	SD-3 to SD-2	296 [970]	1.83 [6]	3.05 [10]	1,660[2,200]	550 [0.13]	0.9 [3]	2,450 [3,200]
Total		686 [2,250]			3,450 [4,600]	1270 [.31]		2,450 [3,200]
216-S-10	**Pond**							
Main Section	Pond	317 [1,040]	25.91 [85]	2.44 [8]	20,030 [26,200]	8,220 [2.03]	0 [0]	0 [0]
Fingers Section	Pond	201 [660]	25.91 [85]	2.44 [8]	12,710 [16,700]	5,220 [1.29]	0 [0]	0 [0]
Total					32,740 [42,900]	13,440 [3.32]		0 [0]
216-S-11	**Pond**							
Section One	Pond	232 [760]	15.24 [50]	3.05 [10]	10,760 [14,100]	3,530 [.87]	0 [0]	0 [0]
Section Two	Pond	24 [80]	82.30 [270]	3.05 [10]	6,120 [8,000]	2,010 [.5]	0 [0]	0 [0]
Total					16,880 [22,100]	5,540 [1.37]		0 [0]

[1] Contamination volumes are rounded up to the next 100 cubic yards.
[2] Contamination volumes are rounded up to the next 10 cubic meters.
[3] Surface areas are rounded up to the next 10 square meters.

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Table 4-2. Preliminary Remediation Goals for Contaminants of Concern (2 Pages)

Site	Contaminants of Concern	COCs for Ecological Receptors	COCs for Ground-water Protection	Ecological Preliminary Remediation Goal[a]		Groundwater Preliminary Remediation Goal[b]		Background Values		
				Value	Source	Value	Source	Lognormal 90th Percentile Value	Lognormal 95th Percentile Value	Source
216-A-29 Ditch	1,2-Dichloroethane		X	N/A	N/A	2.32 (µg/kg)	WAC	N/A	N/A	N/A
	Aroclor-1254	X	X	3,230 (µg/kg)	ORNL	1,306.88 (µg/kg)	WAC	N/A	N/A	N/A
	Benzo(a) anthracene		X	N/A	N/A	86.3 (µg/kg)	WAC	N/A	N/A	N/A
	Bis (2-ethylhexyl) phthalate	X		852 (µg/kg)	ORNL	N/A	N/A	N/A	N/A	N/A
	Cadmium		X	N/A	N/A	0.69 (mg/kg)	WAC	1 (mg/kg)	N/A	Statewide Conc.; Ecology 94-115; Oct. 2004
	Cesium-137	X		20 (pCi/g)	BCG	N/A	N/A	1.05 (pCi/g)	1.51 (pCi/g)	DOE/RL-96-12, Rev.0
	Chrysene		X	N/A	N/A	95.9 (µg/kg)	WAC	N/A	N/A	N/A
	Silver	X		4.2 (mg/kg)	EPA	N/A	N/A	0.73 (mg/kg)	1.52 (mg/kg)	DOE/RL-92-24, V.1, Rev.4
	Tetrachloro ethylene		X	N/A	N/A	0.867 (µg/kg)	WAC	N/A	N/A	N/A
	Tributyl phosphate		X	N/A	N/A	32.4 (µg/kg)	WAC[c]	N/A	N/A	N/A
216-S-10 Ditch	Chromium (total)	X		67 (mg/kg)	WAC	N/A	N/A	18.5 (mg/kg)	22.3 (mg/kg)	DOE/RL-92-24, V.1, Rev.4
	Aroclor-1254	X	X	3,230 (µg/kg)	ORNL	1,310 (µg/kg)	WAC[c]	N/A	N/A	N/A
	Benzo(a) anthracene		X	N/A	N/A	86.3 (µg/kg)	WAC	N/A	N/A	N/A
	Benzo(a) pyrene		X	N/A	N/A	233 (µg/kg)	WAC	N/A	N/A	N/A

Table 4-2. Preliminary Remediation Goals for Contaminants of Concern (2 Pages)

Site	Contaminants of Concern	COCs for Ecological Receptors	COCs for Ground-water Protection	Ecological Preliminary Remediation Goal[a]		Groundwater Preliminary Remediation Goal[b]		Background Values		
				Value	Source	Value	Source	Lognormal 90th Percentile Value	Lognormal 95th Percentile Value	Source
216-S-10 Ditch	Benzo(b) fluoranthene		X	N/A	N/A	288 (µg/kg)	WAC	N/A	N/A	N/A
	Benzo(k) fluoranthene		X	N/A	N/A	288 (µg/kg)	WAC	N/A	N/A	N/A
	Chrysene		X	N/A	N/A	95.9 (µg/kg)	WAC	N/A	N/A	N/A
	Silver	X		4.2 (mg/kg)	EPA	NA	N/A	0.73 (mg/kg)	1.52 (mg/kg)	DOE/RL-92-24, V.1, Rev.4

Aroclor is an expired trademark.

[a] Values are based on soil indicators for terrestrial wildlife.

[b] Values are based on soil cleanup levels for the protection of groundwater obtained from CLARC.

[c] Alternative H_{cc} and K_d values were used to calculated the cleanup levels for this constituent, see Appendix F.

DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes.*

DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides.*

Ecology 94-115, *Natural Background Soil Metals Concentrations in Washington State.*

BCG = biota concentration guideline, found in DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota.*

CLARC = Ecology, 2005, *Cleanup Levels & Risk Calculations (CLARC)* database, available on the Internet at https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx

COC = contaminant of concern and risk driver.

EPA = U.S. Environmental Protection Agency. EPA ecological soil screening levels are available online: http://www.epa.gov/ecotox/ecossl/

ORNL = Oak Ridge National Laboratory. Toxicological benchmarks are in ES/ER/TM-86/R3, *Toxicological Benchmarks for Wildlife: 1996 Revision.*

WAC = *Washington Administrative Code.* Soil indicator values appear in WAC 173-340-900, "Tables," Table 749-3; the groundwater-protection pathway cleanup levels use WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection," Equation 747-1.

5.0 REMEDIAL-ACTION ALTERNATIVE REEVALUATION AND REFINEMENT

The purpose of conducting an FS is to identify and evaluate alternatives for the remediation of waste sites under CERCLA. Remediation alternatives are developed by assembling combinations of viable technologies or associated process options for specific media of concern. The initial process of identifying viable remedial-action alternatives consists of the following steps.

1. Define RAOs (preliminary RAOs were developed in Chapter 4.0)
2. Identify general-response actions to satisfy RAOs
3. Identify potential technologies and process options associated with each general-response action
4. Screen the process options to select a representative process for each type of technology, based on their effectiveness, implementability, and cost
5. Assemble viable technologies or process options retained in Step 4 into alternatives representing a range of removal, treatment, and containment options in addition to a no-action alternative.

After a range of suitable alternatives is developed, a detailed analysis is performed as the final step in the FS process. The detailed-analysis phase consists of refining and analyzing in detail each alternative, generally on a waste site-specific basis. The results of the final FS are used to select a preferred alternative.

The Implementation Plan (DOE/RL-98-28) performed steps 1 through 5 to identify viable remedial-action alternatives for contaminated soil and buried solid waste in the 200 Areas (i.e., source waste sites assigned to the Environmental Restoration Program). The remedial-action alternatives developed in the Implementation Plan (DOE/RL-98-28) are summarized below:

- No action
- Institutional controls
- Engineered surface barriers with or without vertical barriers. Three conceptual surface-barrier designs provide a range of protective levels. Feasible vertical barriers include slurry walls and grout curtains. Dynamic compaction is provided as a foundation-improvement technique for surface barriers when needed
- Excavation and disposal with or without ex situ treatment. Feasible technologies for organic compounds include thermal processing, vapor extraction, and stabilization. Feasible technologies for radionuclides include soil washing, mechanical separation,

vitrification, and stabilization. Options for both on-site and off-site disposal are provided

- Excavation, ex situ treatment, and geologic disposal of soil with transuranic radionuclides
- In situ grouting or stabilization of soil
- In situ vitrification of soil
- In situ soil-vapor extraction of volatile organic compounds
- Monitored natural attenuation.

With the Implementation Plan developing viable remedial-action alternatives, these viable alternatives form the basis for the future alternative review and analysis during any feasibility study in the 200 Area that starts after 1998. Therefore, 200-CS-1 OU FS will limit alternative analysis to the remedial-action alternatives developed in the Implementation Plan and summarized above.

Only a limited amount of source RI has been completed in the 200 Areas and, to a large extent, waste site-specific characterization data are limited. As a result, recommendations for remedial-action alternatives in the Implementation Plan (DOE/RL-98-28) are general and cover a range of potential actions to reflect the broad range of potential contamination conditions in the 200 Areas. Alternatives are expected to require refinements or modifications based on waste site-specific characterization data collected during the RI. These refinements will be made in this FS.

5.1 INTRODUCTION

This section describes the conceptual site model and refinements or modifications of the above alternatives, based on site-characterization data collected during the RI that may be applicable for remediation of the vadose soil associated with the 200-CS-1 OU. Groundwater remediation will be addressed in the FSs conducted for the 200-BP-5, 200-PO-1, 200-UP-1, and 200-ZP-1 Groundwater OUs.

The 200 Areas are an operational industrial complex with numerous facilities, some of which will remain active until at least 2049. However, none of the waste sites in the 200-CS-1 OU are operational. Therefore, this section discusses only alternatives that can be implemented as final actions.

The conceptual site models developed for the 200-CS-1 OU (Sections 3.2 and 3.6) and a summary of the revised BRA were discussed in Section 3.7. Based on the conceptual site models, actions that may meet RAOs include the following:

- Removing sources
- Removing or immobilizing contaminants present in sources

- Eliminating release mechanisms
- Eliminating contaminant-migration pathways
- Eliminating exposure routes
- Controlling access by receptors.

5.2 REFINEMENT AND MODIFICATIONS OF REMEDIAL-ACTION ALTERNATIVES

This section provides additional site-specific information regarding the prescreened remedial alternatives.

5.2.1 Institutional Controls

ICs may meet RAOs by restricting access of receptors to contaminated soil or by eliminating exposure routes. The IC plan (DOE/RL-2001-41) describes the various ICs that currently are implemented at the Hanford Site. The methodologies and overall procedures for implementing, maintaining, and evaluating the effectiveness of ICs for the 200-CS-1 OU waste sites are discussed in the following sections. It is important to note that ICs alone would not be effective in preventing ecological exposure or migration to groundwater. As a result, ICs would be implemented with another technology that would prevent ecological exposure and/or migration to groundwater.

5.2.1.1 Waste Information Data System

The *Waste Information Data System* (WIDS) database serves as a comprehensive listing of all waste sites on the Hanford Site. The WIDS includes entries for each OU and their respective waste sites. Additional data are compiled into each site description, along with descriptions of plant operations. Key drawing lists, references, and photographs of each waste site also are provided. In addition to coding the sites within a group and providing the WIDS designation for each waste site, the boundary locations of the former geographically based OUs also are provided.

5.2.1.2 Access Control

Unauthorized access to the Hanford Site is controlled under the authority given in 42 USC 2278a, "Trespass Upon Commission Installations," as implemented by 10 CFR 860, "Trespassing on Department of Energy Property." The Hanford Site facilities require that all persons wear identification badges to enter. Any member of the general public who visits the Hanford Site must pass through visitor control, obtain a visitor pass, and be escorted by authorized personnel. RL maintains a security force responsible for controlling access to all of the Hanford Site, including the 200 Areas facilities. The access-control procedures used by the security force can be found in DOE O 470.4A, *Safeguards and Security Program*.

Sites that pose a radiological-exposure risk to personnel or visitors are physically and administratively controlled so that only trained radiation workers can access the sites, as designated under 10 CFR 835, "Occupational Radiation Protection." Worker exposure also is maintained under the as-low-as-reasonably-achievable (ALARA) program. Physical controls for accessing CERCLA sites posing radiological hazards include warning signs, fences, barriers, and boundary markers. Administrative controls include radiological work permits and personnel training.

5.2.1.3 Visible Access Restrictions

Visible access restrictions are those ICs that restrict personnel access at a specific CERCLA site. Visible access restrictions may include barriers, permanent markers, or warning signs. Warning signs are the predominant method of access restriction at the Hanford Site. They identify the location of WIDS sites to any persons who may intentionally or inadvertently enter or disturb a site. Warning signs are posted at sites when residual contamination at the sites may pose a current or future risk to human health or the environment if excavated or otherwise disturbed.

5.2.1.4 Transfer to Management by Other Department of Energy Programs or Other Federal Agencies

The ICs put in place pursuant to CERCLA will continue without modification or interruption following transfer of any part of the Hanford Site to another government program or entity. All primary documents bind the Federal government and not just a single element of that government. Neither NEPA nor other environmental laws would require any new action in connection with such an intra-DOE transfer of responsibility.

5.2.2 Monitored Natural Attenuation

Monitoring may be used in combination with other technologies to meet RAOs. Monitoring for 200-CS-1 OU waste soils could include the following:

- Initial determination of extent of contamination above PRGs
- Determination of soil COC concentrations during excavation (see next paragraph)
- Post-remedial-action characterization to determine compliance with cleanup goals
- Long-term monitoring.

Sampling and radiochemical analyses frequently are performed on the Hanford Site to determine soil concentrations. Typical analytical methods and quantitation limits for the COCs in soil are identified in sampling and analysis plans using appropriate analytical methods and quantitation limits for the COCs of interest. Sampling and radiochemical analyses are effective and implementable and are retained for further consideration.

5.2.3 Engineered Surface Barriers

Engineered surface barriers isolate wastes and minimize contaminant migration. When properly constructed and maintained, surface barriers can prevent or reduce migration of hazardous substances into the surrounding environment, eliminate or reduce direct exposure to waste, and control run-on and run-off to the site. While barriers can reduce the mobility of contaminants, they do not reduce the toxicity or volume of contaminants. Engineered surface barriers are discussed in the following paragraphs.

Barriers refer to a wide range of engineered surface-barrier technologies that potentially may meet RAOs by eliminating or controlling secondary release mechanisms, eliminating contaminant-migration pathways, or eliminating exposure routes.

Establishing barriers to prevent exposures to future workers may require approximately 1 m of clean soil over the soil area that has contamination above acceptable risk criteria within the 200-CS-1 OU boundary. For the barrier to be completely effective, the cover would have to provide a layer of clean soil approximately 1 m thick until radioactive decay has reduced the radioactive contaminants to acceptable levels.

Surface barriers would meet RAOs by covering contaminated soil areas with uncontaminated soil, rock, or other materials such as asphalt, concrete, or geosynthetic materials. Vegetation may be established on the surface of soil caps to enhance evapotranspiration (ET), reduce infiltration of water, and control soil erosion. Alternatively, the surface may be paved to allow for industrial end use or mat be covered with rock armor to discourage any end use.

The cover should perform the required functions for the duration of risk. Barriers must be designed for site-specific conditions, including the following:

- Risk mitigation
- ARARs
- Waste characteristics
- Available construction materials
- Site environmental conditions, including climate and precipitation.

Technical requirements for barrier design are defined by the RAOs, the action- and chemical-specific ARARs, and the to-be-considered requirements. Functional requirements for barrier design must consider factors that include the following:

- Possibility for penetration of plant roots, burrowing animals, and insects into the soil and mobilization of waste to the surface
- End use (e.g., vehicular traffic load ratings)
- Site surface and subsurface infrastructure that may interfere with construction
- Climate, including temperature, precipitation, insulation, evaporation, and transpiration
- Potential for inadvertent human intrusion
- Subsidence of underlying materials, which can cause water ponding and increased infiltration
- Stability of the subgrade and of surface and side slopes

- Wind or water erosion
- Catastrophic events, such as earthquakes, volcanoes, wildfires, or floods.

The implementability of any barrier option will be affected by 200-CS-1 OU loading controls and the presence of surface and subsurface infrastructure. Capping would not be constrained by surface infrastructure. Asphalt, concrete, and geosynthetic barriers have been installed and sealed around infrastructure; however, compacted clay barriers cannot be installed as readily over or around surface infrastructure.

Engineered surface-barrier options that may effectively meet the RAOs and ARARs for the 200-CS-1 OU are described below.

5.2.3.1 RCRA Subtitle C Barrier

This type of barrier is designed to meet performance objectives for RCRA Subtitle C landfill closures under 40 CFR 265.310, "Closure and Post-closure Care." EPA/600/2-87/039, *Design, Construction and Maintenance of Cover Systems for Hazardous Waste, an Engineering Guidance Document*, recommends a cap consisting of (top to bottom) an upper vegetated soil layer, a flexible-membrane liner overlying a sand drainage layer, compacted clay barrier, and a grading fill layer over the waste. A gas collection layer may be included if gas-generating wastes are capped. Nominal thickness of this type of barrier is 1.5 m (4.9 ft), and the addition of grading fill would increase the thickness at the crest. Figure 5-1 shows a schematic cross section of a RCRA Subtitle C barrier.

This type of cap is designed to be less permeable than the bottom liner of a RCRA Subtitle C landfill and meets requirements of 40 CFR 265.310. However, other types of barriers may be used if equivalent performance can be demonstrated through numerical modeling and/or site-specific large-scale lysimeter studies.

A RCRA Subtitle C barrier potentially could meet the RAOs identified above. A RCRA Subtitle C barrier is, therefore, technically implementable on the 200-CS-1 OU.

5.2.3.2 Water Balance or Evapotranspiration Barriers

ET barriers contain a thick soil layer with a vegetated surface. ET barriers are designed to manage the water balance of the capped area such that deep infiltration through the barrier to underlying contaminated soil is minimized. Precipitation onto the cover that does not run off is stored within the porosity of a thick soil layer. Soil moisture stored at shallow depths in the cover profile can be removed by direct evaporation, while deeper soil moisture can be removed by cover-vegetation transpiration demand during the growing season.

The ET barrier exploits the high evaporation and transpiration demands exerted by arid and semiarid climates and native plants to maintain low-soil-moisture contents, thereby minimizing unsaturated hydraulic conductivity and infiltration. The soil layer serves to store water and sustain plants during dry periods and also during periods when plants are inactive. Figure 5-2 shows a schematic cross section of a single-layer (monolithic) ET barrier as described in *Technical and Regulatory Guidance for Design, Installation, and Monitoring of Alternative Final Landfill Covers* (ITRC 2003).

Incorporation of capillary barriers consisting of coarse materials (e.g., gravel or cobbles) under the thick soil layer in ET barriers can further reduce infiltration to underlying contaminated soil. At soil-moisture contents below field capacity, water moves in the direction of greater capillary suction and is expressed as negative soil-moisture potential. Capillary suction is inversely proportional to both size of soil-pore space and soil-water content. Moisture potential in a dry layer of coarse-grained gravel and/or cobble is zero, resulting in a barrier to capillary flow between overlying and underlying finer grained layers where pressures are negative. When moisture-potential values in the overlying fine-grained soil approach saturation, water will drain into and through a capillary barrier.

The capillary barrier may be actively or passively vented to remove water vapor and thereby maintain a low moisture content and also may use porous materials (e.g., sandstones or pumice) to provide additional moisture storage in the event that the overlying soil reaches saturation and drains. This variation has been called a "dry barrier" in "Performance and Cost Considerations for Landfill Caps in Semi-Arid Climates" (Ankeny et al. 1997). A biobarrier typically consisting of one or more layers of gravel and cobbles also may be included; alternatively, the capillary barrier may serve as a biobarrier. Figure 5-3 shows a schematic cross section of an ET barrier incorporating a capillary barrier.

A variation to the ET barrier is the monofill barrier, which includes a biobarrier and a silt layer to provide the needed moisture storage (Figure 5-4).

Several features would be incorporated into the ET barrier to protect the topsoil component from erosion. The top layer includes a mixture of pea gravel that will assist in armoring the barrier surface to protect it from wind erosion. Native vegetation will be established on the cover surface to further assist in reducing soil loss from wind and water erosion. The barrier design includes sufficiently thick soil layers to provide performance margins against long-term wind or water erosion (EDF-RWMC-523, *Evaluation of Engineered Barriers for Closure Cover of the RWMC SDA*).

ET barriers have been demonstrated to provide infiltration control equivalent to RCRA Subtitle C barriers under some conditions (ITRC 2003; EGG-WM-10974, *A Simulation Study of Moisture Movement in Proposed Barriers for the Subsurface Disposal Area*). ET barriers would effectively reduce direct radiation exposures to future workers and may reduce flux of contaminants to the groundwater sufficiently to meet RAOs. ET barriers potentially may meet performance objectives for 40 CFR 265.310. Exposure to ecological receptors would be mitigated to varying degrees depending on the specific design. The coarse rock and gravel layers used in a capillary barrier design could reduce or eliminate intrusion of plant roots and burrowing insects and mammals (EDF-RWMC-523). The thick soil layers of an ET barrier lacking a capillary barrier also would reduce exposures to biota.

An ET barrier would require a soil layer at least 1.37 m (4.5 ft) thick to provide adequate soil-moisture storage ("Soil-Plant Cover Systems for Final Closure of Solid Waste Landfills in Arid Regions" [Anderson 1997]) and protection of future workers. The barrier would be technically implementable on the 200-CS-1 OU surface. An ET barrier is, therefore, technically implementable on the 200-CS-1 OU.

5.2.3.3 Rock-Armor Barriers

This type of barrier may include an erosion- and/or intruder-resistant rock-armor surface and potentially a compacted clay barrier (DOE/UMTRA-400642-0000, *Vegetative Covers: Special Study*; DOE/UMTRA-050425-0002, *Technical Approach Document*). These caps have been used in the uranium mill tailings remedial-action program to stabilize uranium mill tailings.

A rock-armor barrier could provide protection of future workers but would not reduce infiltration of water unless underlain by a compacted clay, geosynthetic clay, and/or high-density polyethelene membrane liner. Rock-armor barriers without low-permeability layers increase infiltration rates relative to background conditions because (1) evaporation demand is reduced by the temperature and wind speed reduction at the soil surface afforded by the rock armor and (2) lack of transpiration demand in the absence of plants. A rock-armor barrier would be technically implementable on the 200-CS-1 OU surface.

5.2.3.4 Hanford Barrier

The Hanford barrier, developed for the long-term isolation of Hanford Site wastes, is composed of native earthen materials, geosynthetics, polymeric asphalt, and concrete materials. The Hanford barrier is designed as a water-balance system for long-term (>1,000 years) survivability in semiarid to subhumid environments (PNL-10872, *Hanford Prototype-Barrier Status Report: FY-1995*; WHC-SA-2377-FP, *The Development of Surface Barriers at the Hanford Site*) and is designed to meet RCRA Subtitle C performance objectives. As shown in Figure 5-5, the Hanford barrier is an ET barrier incorporating a capillary barrier, as well as other protective layers, designed to reduce infiltration and to result in a total cover thickness greater than 4.6 m (15 ft) to meet DOE O 435.1, *Radioactive Waste Management*, guidance. This guidance recommends a soil barrier at least 4.6 m (15 ft) thick over buried waste. A 4.6 m (15 ft) thickness of clean soil is assumed to allow for future residential intrusion without exceeding exposure limits.

Asphalt and concrete materials are used in the Hanford barrier below the frost depth and are protected from freeze-thaw damage, ultraviolet light, salt, chemical attack, and contact with water under most conditions. These layers could not be maintained, but functional life would be expected to be longer than when used as surface layers.

A Hanford barrier would provide adequate protection of future workers and essentially would eliminate infiltration of precipitation. A Hanford barrier is technically implementable.

5.2.3.5 Concrete Barrier

Concrete has been used for entombment of structures as well as for closure covers over buried low-level waste (DOE/LLW-105, *Concrete Longevity Overview*). Concrete barriers potentially may inhibit human and biotic intrusion into buried waste and can reduce or eliminate infiltration into underlying waste to meet RAOs. Some concrete structures have survived for centuries; however, concrete is susceptible to damage or attack, including the following:

- Physical damage, such as cracking as a result of subsidence, freeze-thaw action, seismic activity, erosion, and abrasion
- Chemical attack by sulfate, chloride, alkali-aggregate reaction, leaching, acids, and carbonation.

Concrete with a low water-to-cement ratio can have a hydraulic conductivity of less than 10^{-12} cm/s. However, the actual hydraulic conductivity of weathered concrete structures is dominated by cracks (NUREG/CR-5614, *Performance of Intact and Partially Degraded Concrete Barriers in Limiting Fluid Flow*, EGG-2614); therefore, the permeability will increase over time as weathering occurs.

Additives, including sulfur polymer cement, may reduce the effects of chemical attack, increase strength, and increase the functional life of concrete. Sulfur polymer cements potentially are more resistant to chemical attack by acids and salts than Portland-type cements. Sulfur concrete has been demonstrated to be roughly twice as strong as conventional Portland cements concrete in compressive, tensile, and flexural tests, and more resistant to mineral acids and salts (*Sulfur Polymer Cement for the Production of Chemically Resistant Sulfur Concrete* [McBee et al. 1988]).

A concrete barrier would be technically implementable on the 200-CS-1 OU surface.

5.2.3.6 Conventional Asphalt Barrier

A conventional asphalt barrier may consist of a single layer of bituminous pavement over a prepared subgrade to isolate contaminated soil, reduce infiltration, and provide a trafficable surface. An asphalt barrier potentially could help to meet RAOs. Asphalt caps alone would not provide an adequate worker protection barrier. Exposures to ecological receptors would be eliminated as long as the asphalt was maintained.

Asphalt is susceptible to damage by mechanisms including contact with water, which reduces bonding of asphalt and aggregate and may cause swelling of limestone aggregates; freeze-thaw action; fatigue cracking; ultraviolet light; salts; chemicals; petroleum; physical abrasion, and others. Using a seal coating that acts as a barrier between the environment and the asphalt pavement can protect asphalt surfaces. Coal-tar emulsion sealers typically are used, which are resistant to water, gas, oil, salt, chemicals, and ultraviolet radiation. Seal coatings can significantly reduce the hydraulic conductivity of asphalt. Seal coatings must be reapplied relatively frequently to remain effective.

An extended area of an asphalt barrier would be technically implementable on the current 200-CS-1 OU surface.

5.2.3.7 MatCon Asphalt Barrier

MatCon[1] asphalt has been used for RCRA Subtitle C equivalent closures of landfills and soil contamination sites. MatCon is produced using a mixture of a proprietary binder and a specified aggregate in a conventional hot-mix asphalt plant. The EPA Superfund Innovative Technology Evaluation program evaluated MatCon in 2003 (EPA/540/R-03/505A, *Site Technology Capsule: MatCon Modified Asphalt for Waste Containment*) with respect to permeability, flexural strength, durability, and cost. The EPA determined that the as-built permeability of 10^{-7} cm/s was retained for at least 10 years with only minor maintenance and that MatCon had superior mechanical-strength properties and durability.

A MatCon aphalt barrier potentially could help to meet RAOs. However, a MatCon asphalt cap alone would not provide an adequate worker-protection barrier. Exposures to ecological receptors would be eliminated as long as the asphalt was maintained.

5.2.3.8 Flexible-Membrane Barrier

Flexible membranes are single layers of relatively impermeable polymeric plastic (high-density polyethylene membrane liner and others). Flexible membranes are a component of a RCRA Subtitle C cover and, potentially of other cover types, and also may be used alone. Flexible membranes are laid out in rolls or panels and welded together. The resulting membrane cover is essentially impermeable to transmission of water unless breached. Flexible membranes can be sealed around surface infrastructure using waterproof sealants.

5.2.4 In Situ and Ex Situ Treatment Alternative -- Vitrification

In situ and ex situ treatment alternatives potentially may reduce the mobility or volume of 200-CS-1 OU COCs.

In situ and ex situ vitrification thermal treatment of soil is the process of converting materials into glass or glass-like substances at high temperatures. Vitrification is a thermal process that can be performed both in situ and ex situ. The vitrification process involves heating contaminated media to extremely high temperatures and then cooling them to form a solid mass. The vitrification process uses an electric current to melt buried soil or other solid media, including containers, at extremely high temperatures (1,600 to 2,000 °C). Contaminants are immobilized within the vitrified mass. This mass is a chemically stable, leach-resistant material similar to obsidian rock or glass. An electrical distribution system, an off-gas treatment system, and a process-control system are required for implementation. The off-gas system is required for emissions to ambient air during vitrification, because some organic constituents and inorganic contaminants may be volatilized and released as a result of the high temperatures involved. A vacuum hood often is placed over the treated area to

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[1] MatCon is a trademark of Matcon Trading Corp, Miami, Florida.

collect off-gases, which then are treated before release. Vitrification reduces the volume, toxicity, and mobility of the contaminated materials but does not affect their radioactivity. Because the treatment is entirely in situ, no off-site activities are necessary to manage, treat, store, or dispose of waste.

In situ vitrification is a proven, commercially available technology that has been used to vitrify contaminated soil to a depth of about 7.6 m (25 ft). Vitrification to deeper depths (about 12 m [40 ft]) has been achieved using a two-stage melting process. However, this process requires removal of a portion of the overburden soil while melting the lower portion of the soil column. The overburden soil is placed over the vitrified mass and vitrified as a second stage. Emerging research indicates that a single-stage melt to deeper depths may be possible in the near future.

The following are potential capabilities and limitations of vitrification:

- Capabilities:
  - Reduced leachability of immobilized inorganics and radionuclides
  - Long-term durability of the vitrified product that passes leaching tests, such as EPA's extraction, toxicity solid-waste leaching, and toxicity-characteristic leaching procedures
  - Can handle some buried objects, such as steel pipes and tanks
  - Volume reduction
  - Avoidance of excavation, processing, and disposal of soil (especially remote-handled materials) reduces potential exposures.
- Limitations:
  - Waste composition and moisture content
  - Presence of combustible materials
  - Presence of process-limiting materials
  - Volatilization of contaminants will require off-gas collection and treatment; combustible gases may be produced
  - Potential shorting caused by buried utilities and engineered structures
  - Depth limitations
  - High cost of energy

– Highly trained operators required.

5.2.5 Soil Excavation

The COCs in 200-CS-1 OU soil may be physically removed by excavation. Excavation to prevent exposures to ecological receptors and potential migration of COCs to groundwater would require excavating to a maximum depth, based upon the RI/BRA results for the 200-CS-1 OU and backfilling with clean soil.

Several factors affect implementability of excavation technologies at the 200-CS-1 OU.

- A depth of excavation is required, along with shoring requirements for large-scale removals.
- Subsurface infrastructure is present, including tanks and vaults, concrete valve boxes and pipe enclosures, piping, pipe supports, electrical supply, instrumentation, and cathodic protection. Excavation would expose several tank-vault walls, which will require an engineering analysis to determine if they will remain stable or if supports will be required to hold them in place.
- Soil and debris physical characteristics, including bulk density and hardness, may inhibit excavation.
- The potential exists for direct radiation exposure to workers. Conventional excavation techniques and equipment generally can be used in gamma exposure fields of less than 200 mR/h. Shielded or remotely operated equipment typically is required in high radiation fields greater than 200 mR/h to ensure the safety of equipment operators.
- Fugitive dust may be produced, with associated airborne contamination exposure to workers. Soil removal would require the use of engineering and administrative controls to reduce risks caused by fugitive dust emissions, worker exposure, and waste streams. Confinement of the action to as small an area as possible and containment of the excavation site in an enclosure lower these risks.
- There may be ongoing 200-CS-1 OU operations, including tank closures and decontamination and decommissioning of surface structures. Excavation of most 200-CS-1 OU soil could be implemented in 2012, based on current planning schedules.

Because of the expected low direct-radiation exposures that would be encountered during excavation at 200-CS-1 OU locations, only conventional excavators are discussed.

Conventional excavators include backhoes, trackhoes (see Figure 5-6), front end loaders, wheel loaders, Bobcats[2], and others. Conventional excavators could be used to remove soil contaminated at relatively lower radiation levels, as well as removing overburden above soil contaminated at higher levels and laying back excavation side slopes in preparation for contaminated soil removal. Commercially available conventional excavation equipment can be fitted with lead exterior shielding and leaded or Lexan[3] film glass to reduce direct gamma and beta exposures to the operator. Airborne exposures can be minimized using sealed operator cabins and inlet air filtration. Protective clothing, respirators or supplied air, and dust suppression techniques in the working area can further reduce exposures.

Spraying foams or other dust suppressants onto the digface and/or equipment operating area can control fugitive-dust generation and airborne contamination generated during excavation. Fugitive dust and airborne contamination can be contained using tent-type temporary sprung structures or more permanent Butler-type[4] metal buildings. Both types are commercially available.

Conventional excavators and fugitive-dust-generation and airborne-contamination controls are retained for further consideration for 200-CS-1 OU soil removal.

5.2.6 Disposal

Disposal would be used in combination with removal to meet RAOs by isolating contaminated soil in an engineered repository, thereby breaking contaminant migration and exposure pathways. All excavated soil and debris would be disposed of in the Environmental Restoration Disposal Facility, which is assumed to be available for the duration of soil removal. Disposal containers and transportation would be provided by the Environmental Restoration Disposal Facility operating contractor. Compliance with any applicable U.S. Department of Transportation requirements for the haul route from the 200-CS-1 OU to the Environmental Restoration Disposal Facility is assumed to not increase scope, complexity, or cost of disposal.

5.3 SUMMARY OF RETAINED REMEDIAL ALTERNATIVES FOR 200-CS-1 OPERABLE UNIT SOIL

Based on the COCs identified in the 200-CS-1 OU soil and the above discussion on refining and modifying the alternatives identified previously in the Implementation Plan (DOE/RL-98-28), numerous alternatives were retained for the 200-CS-1 OU soil. ICs and

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[2] Bobcat is a registered trademark of Bobcat Company, Bismark, North Dakota.

[3] LEXAN is a registered trademark of General Electric Company, New York, New York.

[4] Butler is a trademark of the Butler Manufacturing Company, Kansas City, Missouri.

monitored natural attenuation, including soil sampling and analysis, were retained for further consideration. Engineered surface-barrier options retained included RCRA Subtitle C, ET, rock-armor, Hanford barrier, concrete, asphalt, MatCon asphalt, and flexible-membrane capping systems. Conventional excavators were identified as removal-process options. For the general-response action of disposal, the Environmental Restoration Disposal Facility was the only process option identified.

Based on the COCs present in the 200-CS-1 OU soil and the discussion in Section 5.2, in situ vitrification thermal treatment was not retained because of low technical implementability at the 200-CS-1 OU. Excavation, ex situ treatment, and geologic disposal of soil with transuranic radionuclides was not retained because of the lack or insufficient quantities of transuranic radionuclides present in the 200-CS-1 OU soil. In situ soil-vapor extraction of volatile organic compounds was not retained, because the COCs identified at the Site are not volatile, so the alternative is not applicable at the 200-CS-1 OU sites. In situ grouting or stabilization of soil was not retained, because this alternative would not reduce the exposure and risk from the radionuclides present in the 200-CS-1 OU soils.

5.4 EVALUATION OF REMEDIAL ALTERNATIVES

Alternatives retained following the reevaluation in Section 5.2 are considered with respect to effectiveness, implementability, and relative cost in this section. No alternatives are eliminated at this stage.

Effectiveness is the most important criterion at this evaluation stage. The evaluation of <u>effectiveness</u> was based primarily on the following:

- The potential effectiveness of process options in handling the estimated areas or volumes of contaminated media and meeting the RAOs
- The potential impacts to worker safety, human health, and the environment during construction and implementation
- The degree to which the processes are proven and reliable with respect to the contaminants and conditions at the site.

The evaluation of <u>implementability</u> includes consideration of the following:

- The availability of necessary resources, skilled workers, and equipment to implement the technology
- Site accessibility and interfering infrastructure
- Potential concerns regarding implementation of the technology
- The time and cost effectiveness of implementing the technology in the physical setting associated with the waste unit.

A relative cost evaluation is provided for comparison among technologies. Relative capital and operation and maintenance costs are described as high, medium, or low. These costs are based on references applicable to the particular process option given (presented in Appendix H), prior estimates, previous experience, and engineering judgment. The costs are not intended for budgetary purposes.

Following is a summary of the process options for the 200-CS-1 OU soils.

5.4.1 Institutional Controls

Effectiveness. ICs can effectively control exposures, and RAOs would be met as long as ICs are implemented. Passive ICs (e.g., deed restrictions, permanent markers) are assumed to remain effective for the duration of risk. Active ICs (e.g., guards, fences) are assumed to not be effective after 2049. The effectiveness of ICs is enhanced when implemented with additional process option(s).

Implementability. ICs currently are implemented at the 200-CS-1 OU. Passive ICs are assumed to be implementable for the duration of risk; however, active ICs are assumed to not be implementable after 2049.

Cost. ICs have relatively low capital and operation and maintenance costs.

5.4.2 Monitored Natural Attenuation – Surface Soil Sampling

Effectiveness. Surface-soil sampling can determine the extent of COC contamination and attainment of PRGs. Soil sampling would not meet RAOs but could be used in combination with other technologies.

Implementability. With adherence to an approved health and safety plan, few implementability concerns are associated with continued monitoring of shallow soil at the 200-CS-1 OU waste sites through 2049. However, contaminants will remain in the 200-CS-1 OU soil above risk-based levels after 2049. Also, implementability of long-term soil monitoring after 2049 at the 200-CS-1 OU is uncertain.

Cost. Costs for soil sampling and analysis are moderate to high.

5.4.3 Engineered Surface Barriers

The types of engineered surface barriers that were retained from Section 5.2 include the RCRA, ET, rock-armor, Hanford, concrete, conventional asphalt, MatCon asphalt, and flexible-membrane barriers. These remedial-action alternatives require monitoring to demonstrate that RAOs are met. The following is an evaluation of each type of engineered surface barrier.

5.4.3.1 RCRA Subtitle C Barrier

Effectiveness. The RCRA Subtitle C barrier can effectively limit moisture infiltration and thereby reduce contaminant migration to groundwater and potentially help to meet RAOs. This barrier would require a thick surface-soil layer to provide adequate soil-moisture storage to sustain plants. The overall thickness of the cover can be designed to provide a clean-soil barrier greater than a depth of 1.22 m (4 ft). A RCRA Subtitle C barrier likely would retain these functions for the duration of risk for worker protection. The thickness of the cover, the membrane liner, and compacted clay or geosynthetic clay would deter biointrusion. Maintenance of the vegetated soil surface of the barrier, such as filling animal burrows, would be required.

Implementability. Implementability of any barrier on the 200-CS-1 OU will not be constrained by any site features or limited by the availability of necessary equipment, materials, or skilled personnel.

The constructability of the RCRA Subtitle C barrier is considered to be moderate. Use of geosynthetic materials would make staged construction more difficult. Surface-barrier construction is similar to other types of earthwork, such as highway construction, with respect to complexity and expertise required. No specialized equipment, personnel, or services are required to implement this alternative. Construction materials are readily available at the Hanford Site or from other local sources.

Cost. A RCRA Subtitle C barrier has relatively moderate capital costs and relatively moderate operation and maintenance costs.

5.4.3.2 Evapotranspiration Barrier

Effectiveness. ET barriers have been demonstrated to provide equivalent infiltration-control performance to RCRA Subtitle C barriers under arid climate conditions and could, therefore, potentially help to meet RAOs. These cover types are built almost entirely using native earthen materials; therefore, service life is estimated to exceed that for RCRA Subtitle C barriers and approach that for the Hanford barrier. The thickness of the cap (about 1.52 to 2.13 m [5 to 7 ft]) is more than sufficient to provide a clean-soil barrier and would reduce the potential for and deter biointrusion. An ET barrier likely would retain these functions for the duration of risk for worker protection. Maintenance of the vegetated soil surface of the cap, such as filling animal burrows, would be required.

Implementability. Implementability of any barrier on the 200-CS-1 OU will not be constrained by any site features or be limited by the availability of necessary equipment, materials, or skilled personnel.

The constructability of the ET barrier is considered high. Because geosynthetic materials are not required, this improves the ability to construct the ET barrier in stages. Surface-barrier construction is similar to other types of earthwork, such as highway construction, with respect to complexity and expertise required. No specialized equipment, personnel, or services are required to implement this alternative. Construction materials are readily available at the Hanford Site or from other local sources.

Cost. An ET barrier has relatively low capital costs and relatively low operation and maintenance costs.

5.4.3.3 Rock-Armor Barrier

Effectiveness. Rock-armor barriers can effectively inhibit human and biotic intrusion into buried waste. A rock armor barrier at least 1.22 m (4 ft) thick may, therefore, meet RAOs. Rock-armor barriers reduce evaporation and transpiration demand on underlying soil and thereby increase infiltration. The cover would have to be underlain with impermeable layers (e.g., a membrane and/or geosynthetic clay) to reduce infiltration through the capped area.

Implementability. Implementability of any barrier on the 200-CS-1 OU will not be constrained by any site features or limited by the availability of necessary equipment, materials, or skilled personnel.

Cost. A rock-armor barrier has relatively low capital and operation and maintenance costs.

5.4.3.4 Hanford Barrier

Effectiveness. A Hanford barrier would limit moisture infiltration and could, therefore, potentially help to meet RAOs. The thickness of the cover (about 4.6 m [15 ft]) is more than sufficient to provide a clean-soil barrier. It would eliminate the potential for biointrusion and would meet RAOs. A Hanford barrier likely would retain these functions. Maintenance of the vegetated soil surface of the cap, such as filling animal burrows, would be required.

Implementability. Implementability of any barrier on the 200-CS-1 OU will not be constrained by any site features or be limited by the availability of necessary equipment, materials, or skilled personnel.

The constructability of a Hanford barrier is considered low to moderate because of the relatively large thickness of the barrier, volume, and variety of materials required. Surface loading produced by the 4.6 m (15-ft-) thick cap would have to be considered. Surface-barrier construction is similar to other types of earthwork, such as highway construction, with respect to complexity and expertise required. No specialized equipment, personnel, or services are required to implement this alternative. Construction materials are readily available at the Hanford Site or from other local sources.

Cost. A Hanford barrier has relatively high capital costs and relatively low operation and maintenance costs.

5.4.3.5 Concrete Barrier

Effectiveness. A concrete barrier could reduce infiltration rates through the capped area to essentially zero and could, therefore, potentially help to meet RAOs. A concrete barrier would not reduce direct-exposure risks in the absence of ICs, unless it was at least 1.22 m (4 ft) thick. The concrete cover would eliminate biointrusion for the functional life of the cover. Operation and maintenance, including repair of damaged areas, would be required for the barrier to remain effective.

Implementability. Implementability of any barrier on the 200-CS-1 OU will not be constrained by any site features or be limited by the availability of necessary equipment, materials, or skilled personnel.

Cost. A concrete barrier would have relatively high capital and moderate operation and maintenance costs.

5.4.3.6 Conventional Asphalt Barrier

Effectiveness. A conventional asphalt barrier with adequate seal coating could reduce infiltration effectively through the capped area and could, therefore, potentially help to meet RAOs. An asphalt barrier would not reduce direct-exposure risks; however, the asphalt barrier would eliminate biointrusion for the functional life of the cover. Operation and maintenance, including repair of damaged areas and repeat seal coats, would be required for the cover to remain effective.

Implementability. Implementability of any barrier on the 200-CS-1 OU will not be constrained by any site features or be limited by the availability of necessary equipment, materials, or skilled personnel.

Cost. An asphalt barrier would have relatively low capital and moderate operation and maintenance costs.

5.4.3.7 MatCon Asphalt Barrier

Effectiveness. A MatCon asphalt barrier effectively could reduce infiltration rates through the capped area to essentially zero and could, therefore, potentially help to meet RAOs. A MatCon asphalt barrier would not reduce direct-exposure risks. The barrier would eliminate biointrusion for the functional life of the cover. Operation and maintenance, including repair of damaged areas, would be required for the cover to remain effective.

Implementability. Implementability of any barrier on the 200-CS-1 OU will not be constrained by any site features or limited by the availability of necessary equipment, materials, or skilled personnel.

Cost. A MatCon asphalt barrier would have relatively high capital and moderate operation and maintenance costs.

5.4.3.8 Flexible Membrane Barrier

Effectiveness. A flexible-membrane barrier could reduce infiltration rates effectively through the capped area to essentially zero and could, therefore, potentially help to meet RAOs.

A flexible membrane barrier would not reduce direct-exposure risks. The cover likely would be combined with a soil layer to hold the cover in place, to be completely effective. Operation and maintenance, including repair of damaged areas, would be required for the barrier to remain effective.

Implementability. Implementability of any barrier on the 200-CS-1 OU will not be constrained by any site features or limited by the availability of necessary equipment, materials, or skilled personnel.

Cost. A flexible membrane barrier would have relatively moderate capital and low operation and maintenance costs.

5.4.4 Soil Excavation

Soil excavation and backfilling with clean soil potentially could meet RAOs.

Effectiveness. Conventional excavators are effective for excavating and handling large quantities of soil, rock, or debris. They also are effective for excavating localized areas of contaminated soil. Conventional excavators would alleviate certain waste groups of inherent risks from soil contamination. Excavation, however, generally is a precursor technology for ex situ treatment and/or disposal.

Implementability. Conventional excavators are administratively feasible. Both the resources and the services required to provide excavation and earthmoving operations are readily available. Earthmoving equipment would require decontamination following remediation.

Cost. Conventional excavators generally have relatively low capital and low operation and maintenance costs.

5.4.5 Disposal

Effectiveness. Disposal alone would not meet RAOs but could help meet RAOs in combination with other technologies.

Implementability. Disposal at the Environmental Restoration Disposal Facility is easily implemented.

Cost. Disposal at the Environmental Restoration Disposal Facility has relatively moderate costs.

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Figure 5-1. Resource Conservation and Recovery Act Subtitle C Barrier.

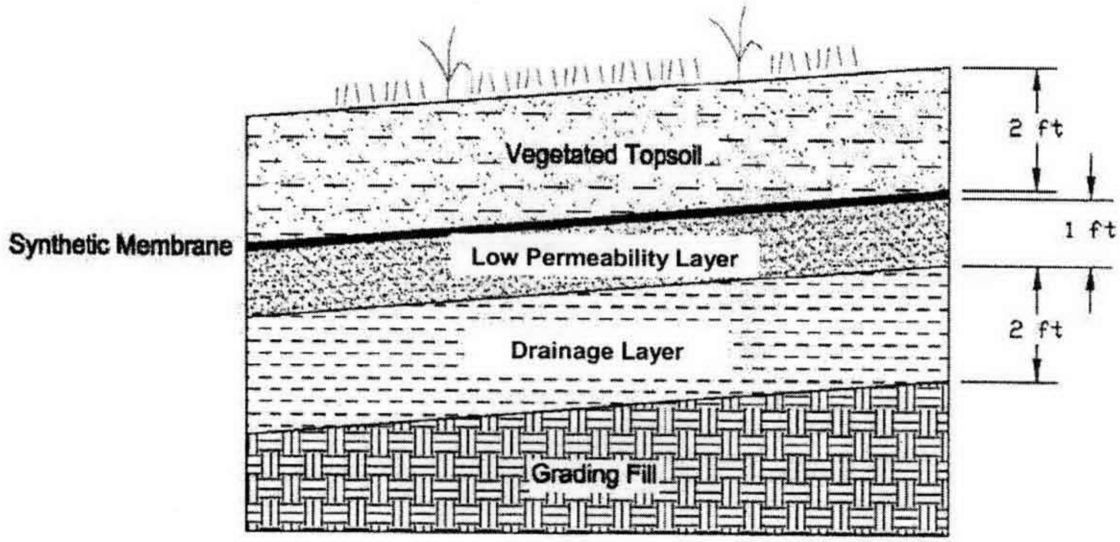


Figure 5-2. Cross Section of a Monolithic Evapotranspiration Barrier.

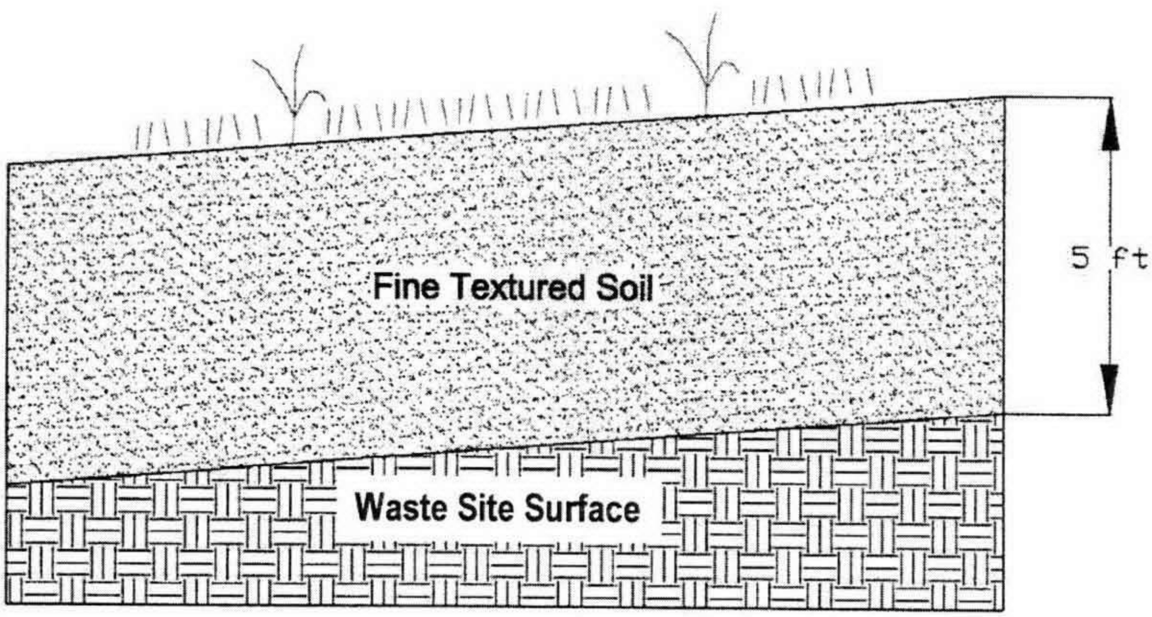
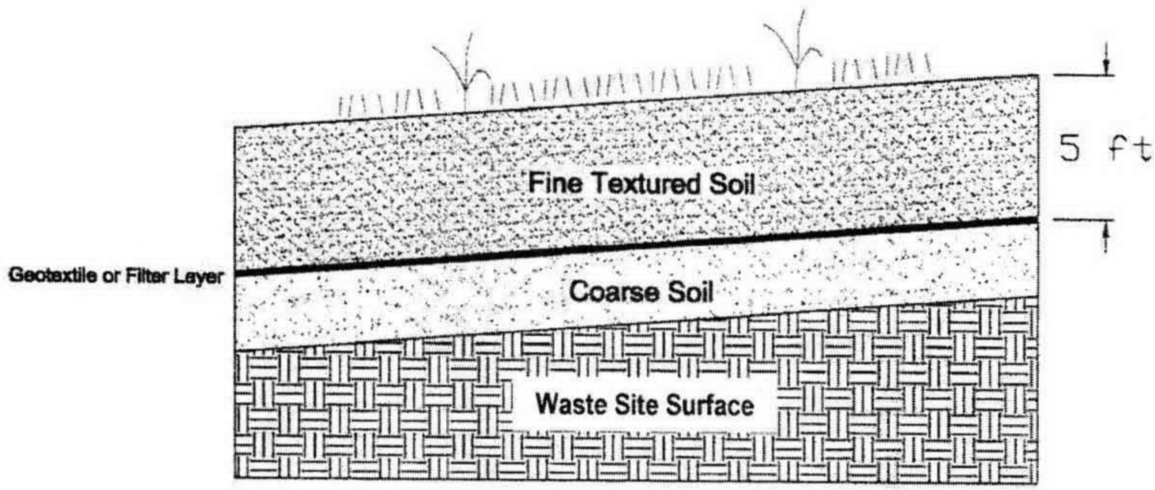


Figure 5-3. Cross Section of an Evapotranspiration Barrier Incorporating a Capillary Barrier.



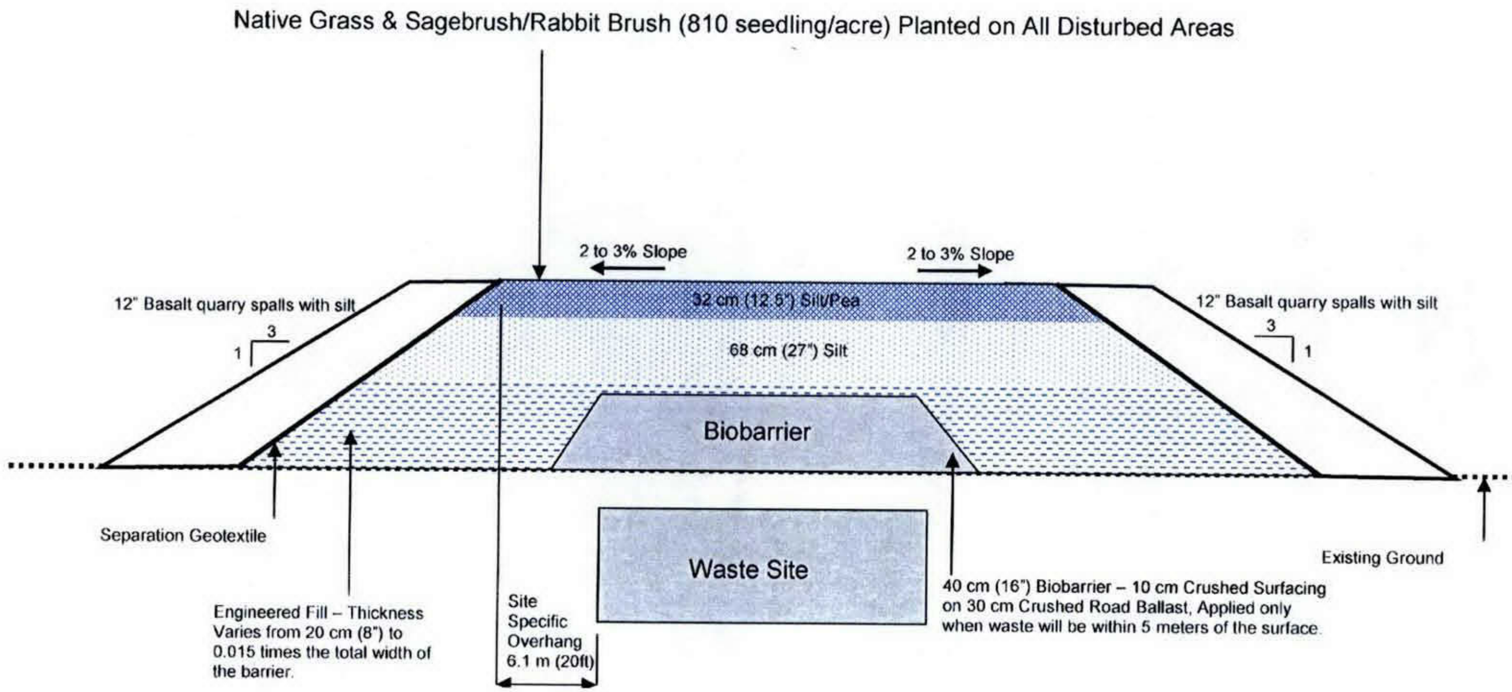


Figure 5-4. Monofill Barrier Design.

Figure 5-5. Cross Section of a Hanford Barrier.

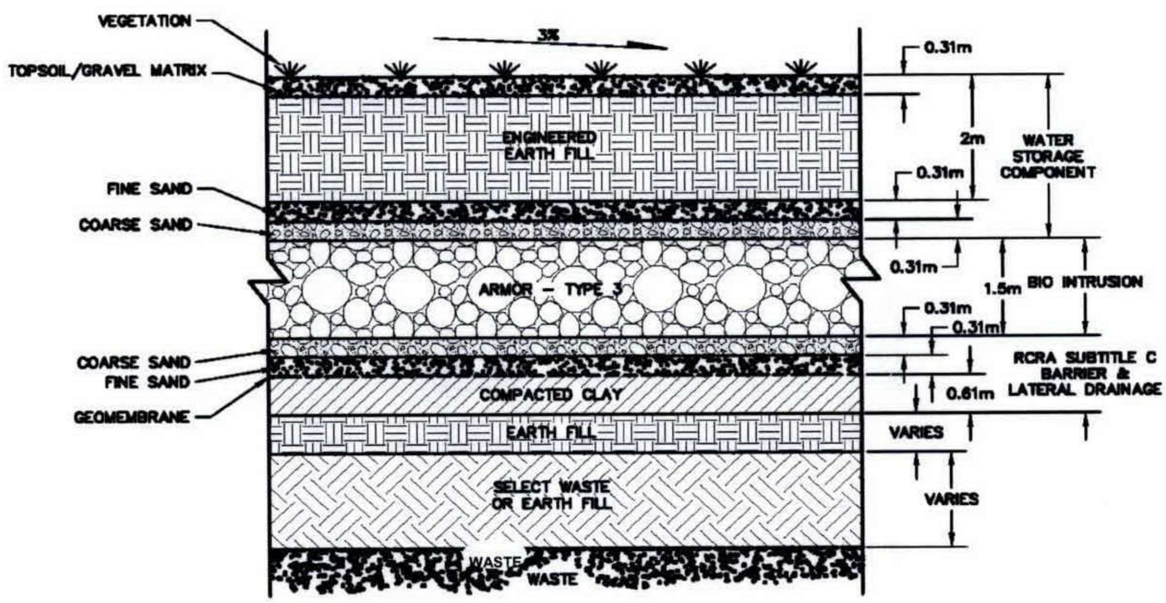


Figure 5-6. Trackhoe Excavator.

6.0 REMEDIAL-ACTION ALTERNATIVES

The EPA guidance for conducting feasibility studies under CERCLA recommends that a limited number of technologies be carried forward from the initial technology identification and screening phase; these technologies then are grouped into remedial alternatives to address site-specific conditions. In Chapter 5.0, technologies were rescreened based on site-specific characteristics and COCs (identified in Chapter 3.0) to determine if they achieve the RAOs (identified in Chapter 4.0). In this chapter, the technologies are grouped into remedial alternatives to address site-contamination problems. Four remedial alternatives are developed and described in this chapter for the waste sites in the 200-CS-1 OU. The four remedial alternatives then are analyzed in Chapter 7.0. The applicability of these alternatives to the individual waste sites also is considered.

6.1 DEVELOPMENT OF ALTERNATIVES

Significant activities and evaluations have contributed to defining applicable technologies and process options that address the 200-CS-1 OU representative and analogous waste sites. The Implementation Plan (DOE/RL-98-28) provides initial information on identification and screening of remedial technologies for 200 Areas waste sites. The Implementation Plan, in conjunction with Chapters 4.0 and 5.0 of this FS, forms the basis for the development of remedial alternatives. The Implementation Plan also develops preliminary remedial alternatives, based on the results of technology screening for the waste sites. Remedial alternatives identified in the Implementation Plan for the 200-CS-1 OU include the following:

- No-action
- Monitored natural attenuation/ICs
- Removal, treatment, and disposal (onsite disposal)
- Containment using surface barriers.

In addition to the remedial alternatives identified in the Implementation Plan and listed above, the alternatives below also were identified in the Implementation Plan but were not retained for further consideration following refinement, modification, and evaluation in Chapter 5.0:

- Excavation, ex situ treatment, and geologic disposal of soil with transuranic radionuclides
- In situ grouting or stabilization of soil
- In situ vitrification of soil
- In situ soil-vapor extraction of volatile organic compounds.

Evaluation of the no-action alternative is a requirement under CERCLA. The monitored natural attenuation/ICs alternative is retained and further developed in this FS for sites where existing remedial actions are in place or where contamination is expected to reach RAOs within a reasonable ICs period. The removal, treatment, and disposal alternative and the containment using surface barriers alternative also are retained and further developed in this FS. The following subsections further develop and describe the alternatives.

One important factor in the development of site-specific remedial alternatives is that radionuclides, heavy metals, and some inorganic compounds cannot be destroyed. As such, these compounds must be physically immobilized, contained, or chemically converted to a less mobile or less toxic form to meet the RAOs.

The institutional controls plan (DOE/RL-2001-41) describes ICs for the current Hanford Site CERCLA response actions. The institutional controls plan describes how the ICs are implemented and maintained and serves as a reference for the selection of ICs in the future. ICs generally include nonengineered restrictions on activities and access to land, groundwater, surface water, waste sites, waste-disposal areas, and other areas or media that contain hazardous substances. This is to minimize the potential for human exposure to the substances. Common types of ICs include procedural restrictions for access, fencing, warning notices, permits, easements, deed notifications, leases and contracts, and land-use controls. The 200-CS-1 OU FS will identify ICs from the institutional controls plan that will be a part of the alternatives listed below.

6.2 DESCRIPTION OF ALTERNATIVES

This section provides a description of the selected alternatives considered for evaluation in this FS, including the following:

- Alternative 1 – No Action
- Alternative 2 – Maintain Existing Soil Cover and Monitored Natural Attenuation
- Alternative 3 – Removal, Treatment, and Disposal
- Alternative 4 – Engineered Barrier.

6.2.1 Alternative 1 – No Action

40 CFR 300 requires that a no-action alternative be evaluated in the FS as a baseline for comparison with other remedial alternatives. The no-action alternative represents a situation where no legal restrictions, ICs, access controls, or active remedial measures are applied to the site. Because no remedial activities would be implemented with the no-action alternative, long-term environmental risks for the 200-CS-1 OU waste sites would be essentially the same as those identified in the revised BRA, except for those associated with radionuclides from radioactive decay over time. No maintenance or other activities are instituted or continued.

6.2.2 Alternative 2 – Maintain Existing Soil Cover and Monitored Natural Attenuation

This alternative takes advantage of existing soil covers and the nature of the contaminants to provide protection of human health and the environment. For all of the waste sites in this OU, except the uncovered segments of the 216-S-10 Ditch, an existing soil cover is present that is associated with the previous waste-stabilization activities. Under this alternative, these existing soil covers will be maintained to provide protection from intrusion by human and/or biological receptors. The existing soil covers provide a barrier between human and ecological receptors and the contaminants.

WAC 173-340-745(7) identifies the points of compliance for different pathways.

- "For soil cleanup levels based on protection of groundwater, the point of compliance shall be established in the soils throughout the site."

- "For soil cleanup levels based on human exposure via direct contact or other exposure pathways where direct contact with the soil is required to complete the pathway, the point of compliance shall be established in the soils throughout the site from the ground surface to fifteen feet below the ground surface."

WAC 173-340-7490, "Terrestrial Ecological Evaluation Procedures," specifies a standard point of compliance at 4.6 m (15 ft) for ecological receptors. Based on literature searches regarding the root and burrowing depths of vegetation and animals present on the Hanford Site, a sufficient soil thickness to prevent biological intrusion generally would be 2.4 to 3.0 m (8 to 10 ft). However, most of the 200-CS-1 OU waste sites have a soil cover (i.e., surface stabilization, backfill) over the contaminated media of approximately 1 m.

For this alternative, periodic surveillance and maintenance of the waste sites will be implemented for evidence of contamination and biologic intrusion. Additional surveillance and maintenance activities under this alternative include the placement of vegetation, herbicide application, manual removal, or other activities to control deep-rooted plants; control of deep-burrowing animals; maintenance of signs and/or fencing; maintenance of the existing soil cover (including an assumed periodic addition of soil); administrative controls; and site reviews.

Contaminants remaining beneath the clean-soil cover would be allowed to attenuate naturally until remediation goals are met. Natural attenuation relies on natural processes to lower contaminant concentrations, while preventing migration of the contaminants to other media, until cleanup levels are met. Monitored natural attenuation would include sampling and/or environmental monitoring, consistent with EPA guidance (EPA/540/R-99/009, *Use of Monitored Natural Attenuation at Superfund RCRA Corrective Action and Underground Storage Tank Sites November 19977*, OSWER 9200.4-17P), to verify that contaminants are attenuating as expected and source control is being maintained. Attenuation-monitoring activities could include monitoring of the vadose zone using soil sampling and analysis methods or groundwater monitoring to verify that natural-attenuation processes are effective. The existing network of groundwater-monitoring wells in the Central Plateau is adequate for monitoring most sites, in coordination with the 200-BP-5, 200-PO-1, 200-UP-1, and 200-ZP-1 Groundwater OUs.

6.2.3 Alternative 3 – Removal, Treatment, and Disposal

Under this alternative, contaminated soil would be removed (by conventional excavation equipment) and disposed of to an appropriate facility (the Environmental Restoration Disposal Facility). A generalized cross-section for this alternative is shown in Figure 6-1.

Soil with contaminant concentrations above the PRGs would be removed using conventional excavation techniques. Excavated materials would be disposed of at an approved disposal facility, currently envisioned as the Environmental Restoration Disposal Facility. Precautions would be used to minimize the generation of onsite fugitive dust. By using a 1.5:1 (horizontal to vertical) side slope, shoring is not expected to be required to comply with safety requirements and to reduce the quantity of excavated soil. The depth, and therefore the volume, of soil removed depends largely on the categories of PRGs that are exceeded. For example, if human-health direct contact or ecological PRGs are exceeded, removals generally would be conducted up to 4.6 m (15 ft) in line with the points of compliance identified in WAC 173-340-745(7) and WAC 173-340-7490. If groundwater protection is required, and depending on the COCs present at the site, soils may be removed to a depth greater than 4.6 m (15 ft) to meet groundwater-protection PRGs. The remediation of soil and associated structures for this alternative would be guided by the observational approach. The observational approach is a method of planning, designing, and implementing a remedial action that relies on information (e.g., samples, field screening) collected during remediation to guide the direction and scope of the activity. Data are collected to assess the extent of contamination and to make "real time" decisions in the field. Targeted (or hot spot) removals could be considered under this alternative if contamination were localized in only a portion of a waste site. The observational approach will be addressed in the remedial design and remedial action phases for the 200-CS-1 OU waste sites.

Based on existing information, soil and/or debris removed from the waste sites will not require treatment to meet Environmental Restoration Disposal Facility waste acceptance criteria (BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*). Additional activities, however, may be required to meet health and safety requirements during excavation, handling, transportation, and disposal. Contaminated soil and/or structures will be containerized (e.g., containers, burrito wraps, bulk shipment) on site and transported to the Environmental Restoration Disposal Facility, located in the 200 West Area.

After the PRGs were met, uncontaminated soil would be used to backfill the excavation. The backfill material could be found at a variety of sources, including local borrow pits and any remaining excavated material that is determined to be clean (verified as clean by meeting the PRGs). Following remediation, the site will be recontoured, resurfaced, and/or revegetated to establish natural site conditions. Maintenance of the site, including weed control (i.e., herbicide application and/or manual removal), is required until the vegetation is sufficiently established to prevent intrusion by noxious, nonnative plants such as cheatgrass and Russian thistle.

6.2.4 Alternative 4 – Engineered Barrier

The engineered-barrier alternative, also known as the capping alternative, consists of constructing surface barriers over contaminated waste sites to control the amount of water that infiltrates into contaminated media, to reduce or eliminate leaching of contamination to groundwater. This barrier will include two options: (1) ET Monofill Barrier and (2) RCRA Subtitle C Cap. In addition to their hydrological performance, barriers also can function as physical barriers to prevent intrusion by human and ecological receptors and limit wind and water erosion. An additional element to the capping alternative is monitored natural attenuation, where contamination undergoes natural processes in a reasonable amount of time.

The preferred capping option for the 200-CS-1 OU is the ET Monofill Barrier, as shown in Figure 6-2. The ET surface barriers rely on the water-holding capacity of a soil, the evaporation from the near surface, and the plant transpiration to control water movement through the barrier. These sites could have a variety of ET barriers; the most appropriate barrier would be determined during remedial design.

Capping technology also will limit the infiltration of precipitation, an important consideration when groundwater protection is required. When the prevention of ecological and human intrusion is a performance requirement, the physical barrier components to the cap become more important. The ET Monofill Barrier includes components that address both of these requirements, whereas the RCRA Subtitle C cap does not address the ecological-intrusion performance requirement.

Use of a capping alternative would require assessment of the lateral extent of contamination during the confirmatory and/or remedial-design sampling phase to properly size the cap to ensure containment. Some degree of oversizing of the barrier beyond the footprint of the waste zone (referred to as overlap) is expected and is dependent on the barrier design used and the depth of contamination. For the purposes of this FS, an overlap of 6.1 m (20 ft) is assumed based on the performance of other Hanford Site-specific barriers. The type and availability of barrier construction materials also is a design consideration. Results of the most recent investigation (BHI-01551, *Alternative Fine-Grained Soil Borrow Source Study Final Report*) will be considered during remedial design for selection of barrier-construction materials.

Caps require surveillance and maintenance throughout their life to ensure continued protection. Performance monitoring will be conducted to ensure that the cap is performing as designed. Performance monitoring for this alternative will be twofold. The first component is groundwater monitoring. The second component is vadose-zone monitoring, if practical. This FS assumes a robust performance monitoring activity during the first five years after construction, followed by a more focused activity in subsequent years.

6.3 INSTITUTIONAL CONTROLS

ICs will be part of Alternatives 2 through 4 as identified in Table 6-1. All ICs in the 200-CS-1 OU alternatives are described in DOE/RL-2001-41. The effectiveness of ICs beyond 2049 is unknown.

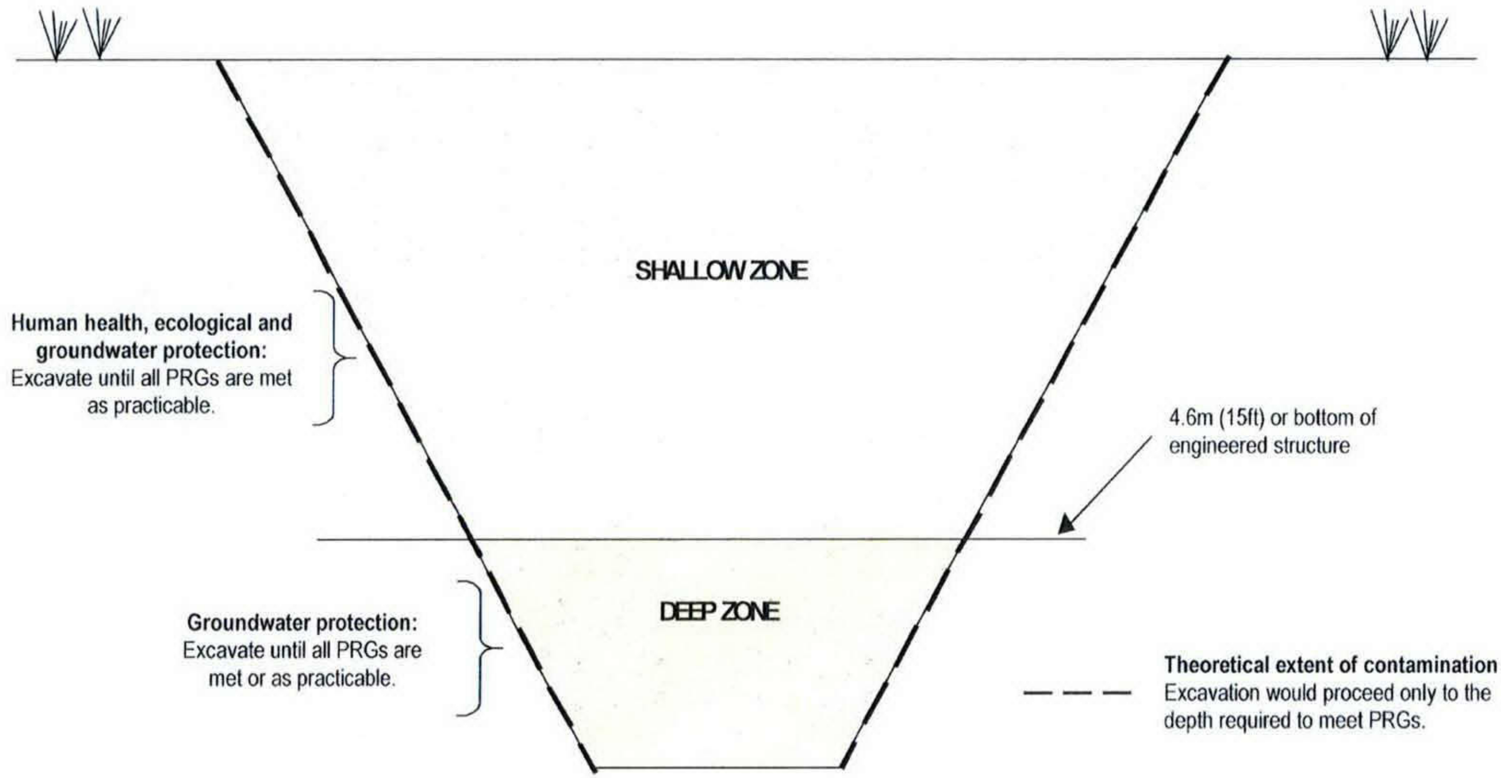


Figure 6-1. Generalized Removal, Treatment, and Disposal Alternative (Alternative 3).

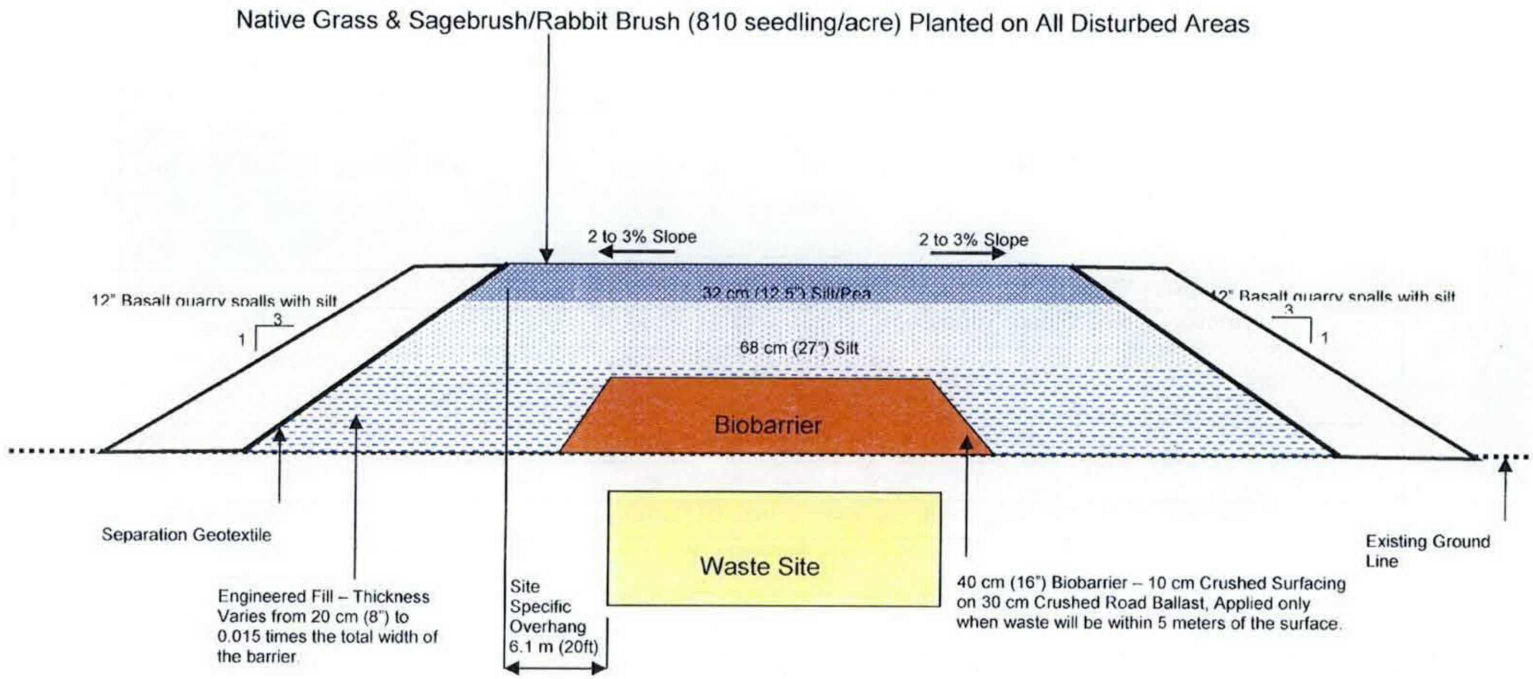


Figure 6-2. Evapotranspiration Monofill Barrier.

Table 6-1. Institutional Controls for 200-CS-1 Operable Unit Alternatives.

Alter-native	Institutional Control	Description	Section of IC Plan [a]
1 [b]	- -	- -	- -
2	Warning Signs	Radiological Control Area	3.2.2
	Entry Restrictions	Control Human Access, Adequate Training, Avoid Disturbance	3.2.3
	Fencing	Prevent Unauthorized Human Access	3.2.3.2
	Land-Use Management	Land-Use And Real Property Controls	3.2.4
	Excavation Permits	Work Control Process	3.2.4.2
	Groundwater-Use Management	Restrict Well Drilling and Groundwater Use	3.2.5
	Waste Site Information Management	Maintain Tracking Mechanism	3.2.6
3	Entry Restrictions	Control Human Access, Adequate Training, Avoid Disturbance	3.2.3
	Land-Use Management	Land-Use And Real Property Controls	3.2.4
	Groundwater-Use Management	Restrict Well Drilling and Groundwater Use	3.2.5
	Waste Site Information Management	Maintain Tracking Mechanism	3.2.6
4	Warning Signs	Radiological Control Area	3.2.2
	Entry Restrictions	Control Human Access, Adequate Training, Avoid Disturbance	3.2.3
	Fencing	Prevent Unauthorized Human Access And Protect Barriers	3.2.3.2
	Land-Use Management	Land-Use And Real Property Controls	3.2.4
	Excavation Permits	Work Control Process	3.2.4.2
	Groundwater-Use Management	Restrict Well Drilling and Groundwater Use	3.2.5
	Waste Site Information Management	Maintain Tracking Mechanism	3.2.6

[a] IC Plan = DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions*.
[b] The no-action alternative represents a situation where no legal restrictions, access controls, or active remedial measures are applied at the site.

7.0 DETAILED ANALYSIS OF ALTERNATIVES

This chapter presents a detailed analysis of the remedial-action alternatives described in Chapter 6.0 for the 200-CS-1 OU waste sites included in this FS. The remedial-action alternatives are evaluated relative to seven of the nine CERCLA criteria, described in Chapter 8.0. The RAOs are assessed for each site to determine if CERCLA evaluation criteria are met. The remedial alternatives were developed in Chapter 6.0 and were based on the site-specific COCs and COECs (identified in Chapter 3.0), RAOs presented in Chapter 4.0, and the available technologies discussed in Chapter 5.0. In this chapter, the remedial alternatives are evaluated to determine if they meet the CERCLA evaluation criteria. Chapter 8.0 then will compare each alternative to provide a relative performance in relation to the CERCLA evaluation criteria.

Four representative waste sites for the 200-CS-1 OU are included in this FS, as discussed in Chapter 2.0. They include the 216-A-29 Ditch, the 216-B-63 Trench, the 216-S-10 Ditch, and the 216-S-10 Pond. The analogous waste site 216-S-11 Pond was assigned to the representative waste site 216-S-10 Pond, based on physical similarities, waste-management function (i.e., disposal versus conveyance), and similarities in the expected distribution of contamination using available information and process knowledge. For this reason, the analogous waste site is assumed to have contaminant distributions and risks similar to those of the representative waste site. Therefore, the detailed analysis for the representative waste site is considered appropriate for the analogous waste site with the addition of any site-specific, dimension-based information (e.g., footprint and depth of risk drivers). The assignment of the analogous waste site to the representative waste site is explained in detail in Chapter 2.0.

The detailed analysis is presented by alternative. Within each alternative, each site is compared with each CERCLA evaluation criterion, including compliance with ARARs. Table 7-1 provides a summary of the ARARs for each alternative, and Tables 7-2 through 7-5 provide a summary of the detailed analyses for the representative waste sites and the one analogous waste site.

The sites are analyzed in the following order:

- 216-A-29 Ditch
- 216-B-63 Trench
- 216-S-10 Ditch
- 216-S-10 Pond and its analogous waste site, the 216-S-11 Pond.

Analysis of the alternatives takes into account the nature of the contaminants at each site and the assumed land use. Currently, land use for the 200 Areas is industrial in nature, associated with the management of waste. This land use can be reasonably predicted to be the same for the next 50 years, given the DOE's current commitment to vitrify waste in the tank farms. Industrial use is assumed in the foreseeable future.

No human health risks for an industrial scenario were identified in the BRA.

The BRA found that constituents present at the 216-A-29 Ditch and the 216-S-10 Ditch posed a potential threat to groundwater, because site concentrations were greater than the WAC three-phase model and chemical contaminants were estimated to migrate through the soil column to groundwater. Table 3-14 summarizes the COCs/COECs considered risk drivers for the groundwater-protection pathway by waste site. There were no groundwater-protection pathway risk drivers identified at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

The BRA found that constituents present at the 216-A-29 Ditch and the 216-S-10 Ditch waste sites pose a potential threat to ecological receptors (see Table 3-14). There were no ecological risk drivers identified at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

Table 4-1 summarizes the volumes of contaminated soil by waste site, based on the risks identified in the revised BRA. Although there is uncertainty associated with the risk assessment (see Section 3.7), estimated volumes range from 1,740 m^3 (2,300 yd^3) for Segment 2 of the 216-A-29 Ditch to 2,450 m^3 (3,200 yd^3) for the uncovered Segment 2 of the 216-S-10 Ditch. These segment designations were discussed in Chapter 4.0 and also are presented in Section 7.2 below.

7.1 DESCRIPTION OF EVALUATION CRITERIA

The EPA has developed nine CERCLA evaluation criteria, defined in EPA/540/G-89/004, to address the statutory requirements and the technical and policy considerations important for selecting remedial alternatives. These criteria serve as the basis for conducting detailed and comparative analyses and for the subsequent selection of appropriate remedial actions.

The nine CERCLA evaluation criteria are as follows:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance.

The first two criteria, overall protection of human health and the environment and compliance with ARARs, are threshold criteria. Alternatives that do not protect human health and the environment, those that do not comply with ARARs (or do not justify a waiver), and those that do not meet statutory requirements are eliminated from further consideration in this FS.

The next five criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost) are balancing criteria on which the remedy selection is based. The CERCLA guidance for conducting an FS lists appropriate questions to be answered when evaluating an alternative against the balancing criteria (EPA/540/G-89/004). The detailed analysis process in this section addresses these questions, providing a consistent basis for the evaluation of each alternative.

The final two criteria, State and community acceptance, are modifying criteria. The criterion of State acceptance will be addressed in the proposed plan prepared by the Tri-Parties. The proposed plan will identify the preferred remedy (or remedies) accepted by the Tri-Parties. The criterion of community acceptance will be evaluated following the issuance of the proposed plan for public review and comment.

In addition to the CERCLA criteria, NEPA values have been incorporated into this document. Assessment of these considerations is important for the integration of NEPA values into CERCLA documents, as called for by the memorandum *Secretarial Policy on the National Environmental Policy Act* (DOE, 1994) and DOE O 451.1B, *National Environmental Policy Act Compliance Program.* Potential effects on NEPA values are discussed in this section.

7.1.1 Overall Protection of Human Health and the Environment

This criterion determines whether adequate protection of human health and the environment, including preservation of natural systems and biological diversity, is achieved through implementation of the remedial-action alternative. Protection includes reducing risk to acceptable levels, either by reducing contaminant concentrations or by eliminating potential routes for exposure, and minimizing exposure threats introduced by actions during remediation. Environmental protection includes avoiding or minimizing impacts to natural, cultural, and historical resources. This criterion also evaluates the potential for human-health risks, the extent of those risks, and whether a net environmental benefit will result from implementing the remedial alternative.

This first criterion is a threshold requirement and is the primary objective of the remedial-action program. This FS addresses both ecological risk and protection of groundwater based on an industrial land-use scenario. No human-health risks for an industrial scenario were identified in the BRA. Potential COCs/COECs were determined based on human health, ecological, and groundwater-protection criteria, as discussed in Sections 3.4, 3.5, and 3.6.

7.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

The ARARs are any appropriate standards, criteria, or limitations under any Federal environmental law or more stringent State requirement that must be either met or waived for any hazardous substance, pollutant, or contaminant that will remain on site during or after completion of a remedial action. The ARAR identification process is based on CERCLA guidance (EPA/540/2-88/002, *Technological Approaches to Cleanup of Radiologically Contaminated Superfund Sites*; EPA/540/G-89/004). Potential Federal and State chemical-, location-, and action-specific ARARs associated with remediation of the waste sites addressed in this FS are presented in Appendix G, and each alternative is assessed for compliance against these ARARs. When an ARAR cannot be met, the lead agency can request a waiver if there is a solid basis for justifying the waiver.

7.1.3 Long-Term Effectiveness and Permanence

This criterion addresses the results of a remedial action in terms of risks that remain at the site after RAOs are met. The primary focus of this evaluation is the extent and effectiveness of the controls that could be required to manage the risk posed by treatment residuals and/or untreated wastes. The following components of the criterion are considered for each alternative.

- Magnitude of residual risk to receptors. This factor assesses the residual risk from untreated waste or treatment residue after remedial activities are completed. The characteristics of the residual waste are considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- Adequacy and reliability of controls. This factor assesses the adequacy and suitability of controls used to manage treatment residues or untreated wastes that remain at the site. It also assesses the long-term reliability of management controls for providing continued protection from residues, and it includes an assessment of the potential need to replace the alternative's technical components.

7.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The degree to which the alternatives employ treatment or recycling that reduces toxicity, mobility, or volume will be assessed, including how the treatment is used to address the principal threats posed by the release sites. Factors that will be considered, as appropriate, include the following:

- Treatment or recycling processes that the alternatives employ and the materials that they will treat

- The amount of hazardous substances, pollutants, or contaminants that will be destroyed or recycled

- The degree of expected reduction in toxicity, mobility, or volume of the waste because of the treatment or recycling and the specification of which reductions are occurring

- The degree to which the treatment is irreversible

- The type and quantity of residuals that will remain following treatment, taking into consideration the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents
- The degree to which treatment reduces the inherent hazards posed by the principal threats at the release sites.

7.1.5 Short-Term Effectiveness

This criterion evaluates the potential effects on human health and the environment during the construction and implementation phases of a remedial action until remedial response objectives are met. Under this criterion, alternatives are evaluated with respect to their effects during implementation of the remedial action. The following factors are considered for each alternative:

- Protection of the community during remedial actions from any risks that result from fugitive dust, transportation of hazardous materials, or air-quality impacts that may affect human health
- Protection of workers from threats that may be posed during remedial actions. Evaluates the effectiveness and reliability of protective measures that would be taken during construction and implementation of the remedial action
- Potential adverse environmental impacts that may result from the construction and implementation of an alternative. Evaluates the reliability of the available mitigation measures in preventing or reducing the potential impacts
- The amount of time until the RAOs are achieved.

7.1.6 Implementability

This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of the required services and materials.

The following factors are considered for each alternative:

- Technical feasibility
  - The likelihood of technical difficulties in constructing and operating the alternative
  - The likelihood of delays because of technical problems
  - Uncertainties related to innovative technologies (e.g., failures)
- Administrative feasibility

  - The ability to coordinate activities with other offices and agencies
  - The potential for regulatory constraints to develop (e.g., as a result of uncovering buried cultural resources or encountering endangered species)
- Availability of services and materials.
  - The availability of adequate onsite or offsite treatment, storage capacity, and disposal services, if necessary
  - The availability of necessary equipment, specialists, and provisions to ensure obtaining any additional resources, if necessary.

7.1.7 Cost

This criterion considers the cost of implementing a remedial-action alternative, including capital costs, operation and maintenance costs, and monitoring costs. The cost evaluation also includes monitoring of any restoration or mitigation measures for natural, cultural, and historical resources.

The cost estimates for the purposes of this study are in present-worth costs. The cost estimates were prepared from information available at the time of this study. The actual cost of the project will depend on additional information gained during the remedial design phase, the final scope and design of the selected remedial action, the schedule of implementation, the competitive market conditions, and other variables. However, most of these factors are not expected to significantly affect the relative cost differences of alternatives.

7.1.8 State Acceptance

This criterion evaluates the technical issues and concerns that the EPA and Ecology could have regarding a remedial-action alternative. The regulatory acceptance process would involve a review and concurrence by the EPA and Ecology. This criterion will be addressed at the time that the proposed plan is published.

7.1.9 Community Acceptance

This criterion evaluates the issues and concerns that the public may have regarding a remedial-action alternative. This criterion will be addressed following public review of the proposed plan.

7.2 DETAILED ANALYSIS OF ALTERNATIVES

This section presents a detailed analysis of the alternatives evaluated under an industrial (exclusive) land-use scenario. Detailed evaluations were performed at the 216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, and 216-S-10 Pond. Data obtained at the representative waste site 216-S-10 Pond were used to evaluate the analogous waste site 216-S-11 Pond.

For the purposes of this analysis, the 216-A-29 Ditch and the 216-S-10 Ditch are divided into segments to aid in the evaluation of alternatives. The 216-A-29 Ditch is divided into two segments as follows: Segment 1 extends from Test Pit AD-2 to Test Pit AD-3 and Segment 2 extends from Test Pit AD-3 to Test Pit AD-1 (see Figure 4-1). The 216-S-10 Ditch is divided into three segments as follows: the covered portion of the ditch extends from Test Pit SP-1 to Test Pit SD-1, the uncovered Segment 1 extends from Test Pit SD-1 to Test Pit SD-3, and the uncovered Segment 2 extends from Test Pit SD-3 to Test Pit SD-2 (see Figure 4-2).

Based on the results of the BRA presented in Chapter 3.0, environmental COCs/COECs that justify a remedial action are present at the 216-A-29 Ditch and the 216-S-10 Ditch. COCs/COECs present at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds do not justify a remedial action at these waste sites. These COCs/COECs for the 216-A-29 Ditch and the 216-S-10 Ditch, along with the associated depths, are presented in Table 3-14.

COCs and COECs identified at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds do not justify a remedial action at these waste sites. Therefore, these sites do not require a cleanup response based on human-health, ecological, or groundwater-protection pathway risks. However, additional RESRAD analysis was performed for the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds using the same input parameters used for the BRA, except that the soil cover was removed and was not included in the model, to evaluate the risk to industrial workers from radiological contaminants (DOE Order 5400.5, *Radiation Protection of the Public and the Environment*) present at these sites. Based on the results of the additional RESRAD analysis, a dose and risk was present for industrial workers at the 216-B-63 Trench; therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained for at least 150 years to protect industrial workers. The RESRAD analysis for the representative waste site 216-S-10 Pond and its analogous waste site 216-S-11 Pond demonstrated that the soil cover is not needed to protect industrial workers. See Appendix E for further details on the additional RESRAD modeling for the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

The following detailed evaluations are applicable to the representative waste sites and the one analogous waste site. Unless noted, when a waste site name is used, it refers to the representative waste site plus the associated analogous waste site.

7.2.1 Detailed Analysis of Alternative 1 – No Action

Alternative 1 is retained for detailed analysis as a baseline description of the effects of taking no action and because it is required by CERCLA regulations.

7.2.1.1 Overall Protection of Human Health and the Environment

216-A-29 Ditch – The no-action alternative would provide overall protection of human health for the 216-A-29 Ditch, because no human-health COCs are present at this site (see Section 3.7). However, the no-action alternative would fail to provide overall protection of the environment for the 216-A-29 Ditch. This is because ecological and groundwater-protection risk drivers present at the site would remain in place based on a no-action approach. No measures would be taken to prevent intrusion into the contaminants; to treat the waste materials and reduce the toxicity and/or volume of the contaminants; or to monitor their migration.

216-B-63 Trench – At the 216-B-63 Trench, the no-action alternative would not provide overall protection of human health and the environment, because the existing soil cover may degrade and, based on RESRAD modeling assuming that no soil cover exists, radiological contaminants would pose an unacceptable risk to industrial workers.

216-S-10 Ditch – The no-action alternative would provide overall protection of human health, because no human-health COCs are present at the 216-S-10 Ditch (see Section 3.7). However, based on environmental-protection criteria, the no-action alternative would fail to provide overall protection of the environment for the 216-S-10 Ditch. This is because ecological and groundwater-protection risk drivers present at the 216-S-10 Ditch would remain on site, with no measures being performed to prevent intrusion into the contaminants; to treat the waste materials and reduce the toxicity and/or volume of the contaminants; or to monitor their migration.

216-S-10 Pond and 216-S-11 Pond – At the 216-S-10 Pond and 216-S-11 Pond, the no-action alternative would provide overall protection of human health and the environment, because no risk drivers are present at these sites.

7.2.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Based on a review of the ARARs presented in Appendix G, several ARARs were identified as applicable to Alternative 1 and were evaluated for each of the waste sites. In addition to the discussion below, a summary of the ARARs for each alternative is presented in Table 7-1.

Chemical-specific ARARs identified for this alternative include those related to national primary drinking water regulations under 40 CFR 141; polychlorinated biphenyl remediation, waste storage, and disposal under 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions"; and soil-cleanup standards for industrial properties under WAC 173-340-745(5)(b). Action-specific ARARs identified for this alternative include those related to closure/postclosure of dangerous waste sites and dangerous waste landfills under WAC 173-303-610 ("Dangerous Waste Regulations," "Closure and Post-Closure") and WAC 173-303-665 ("Landfills"), respectively. These ARARs are not applicable to the sites where the COCs and COECs do not justify remedial actions, which include the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

Alternative 1 involves a no-action approach, which would not minimize or eliminate contaminants to the extent necessary to protect human health or the environment. This means that human-health, ecological and/or groundwater-protection criteria would not be achieved, and no action would be taken to control exposure pathways to the contaminants. Therefore, this alternative would not meet the ARARs identified for the 216-A-29 Ditch and the 216-S-10 Ditch.

7.2.1.3 Long-Term Effectiveness and Permanence

Alternative 1 does not provide long-term engineered controls to limit exposures of human and ecological receptors to contaminated soil or downward migration of contaminants to groundwater. Therefore, there is no change to risks estimated in the BRA. The risk for environmental protection at the 216-A-29 Ditch and the 216-S-10 Ditch is deemed unacceptable; therefore, Alternative 1 for these waste sites does not meet this criterion under CERCLA.

COCs and COECs identified at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds do not justify remedial actions. Additional RESRAD modeling was performed for the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds using the same input parameters that were used for the BRA (except that the soil cover was removed and was not included in the model) to evaluate the risk to industrial workers from radiological contaminants (DOE Order 5400.5) present at these sites. Based on the results of the additional RESRAD analysis, a dose and risk was present for industrial workers assuming that no cover was present at the 216-B-63 Trench; therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained for at least 150 years to protect industrial workers. Because Alternative 1 would not provide long-term maintenance of the existing soil cover at the 216-B-63 Trench, this alternative for this waste site does not meet the long-term effectiveness criterion under CERCLA.

The RESRAD modeling for the 216-S-10 Pond and its analogous waste site 216-S-11 Pond demonstrated that the soil cover is not needed to protect industrial workers from radiological contaminants present at these sites. Therefore, Alternative 1 for the 216-S-10 and 216-S-11 Ponds meets the long-term effectiveness criterion under CERCLA. See Appendix E for further details on the additional RESRAD analysis for the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

7.2.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment would not be implemented with the no-action alternative. Reduction of toxicity, mobility, or volume would occur at all of the waste sites in the form of natural attenuation. Natural attenuation is a process that results in a reduction of toxicity, mobility, or volume through the natural radioactive-decay process. Radioactive decay is the only process currently available to eliminate nuclear-particle emissions. The radioactive-decay process would influence some of the contaminants identified during characterization. In addition, the heavy metals and Aroclor-1254 (a polychlorinated biphenyl) are persistent in the environment and require a long period to attenuate naturally.

In EPA/540/R-99/009, the EPA acknowledges that natural attenuation can be an appropriate treatment for contaminated soil. Because of uncertainties in the science of natural-attenuation processes, the EPA considers source control and performance monitoring to be fundamental components of the remedy. Based on the risk assessment, no risk drivers are present at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds. Therefore, Alternative 1 meets this criterion under CERCLA for these waste sites where the COCs and COECs do not justify remedial actions.

Ecological and groundwater protection risk drivers are present at the 216-A-29 Ditch and the 216-S-10 Ditch. Because the no-action alternative does not use any source control or monitoring to demonstrate treatment, and because of the concentrations of contaminants and the substantial length of time required for natural attenuation processes to meet PRGs, this alternative fails to meet this criterion under CERCLA for the 216-A-29 Ditch and the 216-S-10 Ditch.

7.2.1.5 Short-Term Effectiveness

There would be no short-term risks to the public or workers and no impact on the environment from the no-action alternative, because remedial activities would not be conducted. Current environmental risks would not be mitigated as part of the no-action alternative. In this alternative, RAOs only can be fully met through natural attenuation of contaminants, which can take hundreds of years to achieve and which will not meet RAOs in the short-term time frame. This alternative meets the short-term effectiveness criterion under CERCLA for the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds. However, this alternative does not meet the short-term effectiveness criterion under CERCLA for the 216-A-29 Ditch and the 216-S-10 Ditch.

7.2.1.6 Implementability

The no-action alternative could be implemented immediately and would not present any technical problems. Radionuclides at the waste sites addressed by this FS currently are undergoing natural attenuation by radioactive decay. Other COCs and COECs also are undergoing natural attenuation, where natural processes different than radioactive decay are involved.

7.2.1.7 Cost

The no-action alternative would involve no direct cost, because there will be no activities for this alternative at any of the five sites. A detailed analysis summary for Alternative 1 – No-Action is included in Table 7-2.

7.2.2 Detailed Analysis of Alternative 2 – Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls

Under this alternative, existing soil covers would be maintained to provide protection from intrusion by human and/or biological receptors. The existing soil covers and/or caps would break the pathway between human and ecological receptors and the contaminants. In addition to the soil covers, legal and physical barriers would be used to prevent human access to the site. Groundwater monitoring is included in this alternative.

The following sections present a detailed analysis of Alternative 2 against the evaluation criteria. This analysis is summarized in Table 7-3.

7.2.2.1 Overall Protection of Human Health and the Environment

Alternative 2 would provide overall protection of human health and the environment for sites that demonstrate protection of groundwater (i.e., sites where contaminant concentrations are below groundwater protection cleanup levels), and achieve human-health and environmental protection, within 500 years. Because the viability of ICs cannot be ensured past 500 years, this alternative fails to meet this criterion for sites with long-lived contaminants such as heavy metals, because the waste sites would have contamination that would not attenuate to acceptable levels within 500 years. As discussed in Section 6.2.2, WAC 173-340-745(7) and WAC 173-340-7490 specify that the point of compliance shall be established in the soils throughout the site from the ground surface to 4.6 m (15 ft) bgs to provide protection of human health and the environment. Existing clean-soil covers at the four representative waste sites and the analogous waste site are only approximately 1 m thick and do not meet the point of compliance requirement for protection of human health and the environment.

216-A-29 Ditch – No human-heath COCs are present at the 216-A-29 Ditch (see Section 3.7); however, contaminants at this waste site exceed ecological and groundwater-protection criteria in the 0 to 4.6 m (0 to 15 ft) zone. As such, this alternative is not protective of the environment.

216-B-63 Trench – Alternative 2 would provide long-term maintenance of the existing soil cover and would prevent exposure of industrial workers to unacceptable risk. Therefore, this alternative is protective of human health and the environment at this waste site.

216-S-10 Ditch – No human-heath COCs are present at the 216-S-10 Ditch (see Section 3.7); however, contaminants at this site exceed ecological and groundwater-protection criteria in the 0 to 4.6 m (0 to 15 ft) zone. As such, this alternative is not protective of the environment.

216-S-10 Pond and 216-S-11 Pond – At the 216-S-10 Pond and 216-S-11 Pond, Alternative 2 would provide overall protection of human health and the environment, because COCs/COECs present at these sites do not justify remedial actions.

7.2.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

Based on a review of the ARARs presented in Appendix G, several ARARs were identified as applicable to Alternative 2 and were evaluated for each of the waste sites. In addition to the discussion below, a summary of the ARARs for each alternative is presented in Table 7-1.

Chemical-specific ARARs identified for this alternative include those related to national primary drinking water regulations under 40 CFR 141; polychlorinated biphenyl remediation, waste storage, and disposal under 40 CFR 761; and soil-cleanup standards for industrial properties under WAC 173-340-745(5)(b). Action-specific ARARs identified for this alternative include those related to closure/post-closure of dangerous-waste sites and dangerous-waste landfills under WAC 173-303-610 and WAC 173-303-665, respectively. These ARARs are not applicable to the sites/segments where no risk drivers are present, which include the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

Alternative 2 involves maintaining existing soil covers and allowing contaminants beneath the soil covers to naturally attenuate until remediation goals are met. A minimum soil cover of 4.6 m (15 ft) is required to provide a sufficient barrier to protect the environment. Existing soil covers at the 216-A-29 Ditch and the 216-S-10 Ditch are only approximately 1 m thick and do not meet the thickness requirement. In addition, some of the contaminants such as heavy metals that are present at these waste sites would require a long period to naturally attenuate. Under this alternative, a sufficient barrier would not be installed to protect the environment during that time. Therefore, this alternative would not minimize or eliminate contaminants to the extent necessary to protect the environment. This means that environmental-protection criteria would not be achieved, and existing soil covers would not be sufficient to control exposure pathways to the contaminants. Therefore, this alternative would not meet the ARARs identified for the 216-A-29 Ditch and the 216-S-10 Ditch.

7.2.2.3 Long-Term Effectiveness and Permanence

Alternative 2 does not provide long-term engineered controls to limit exposures of human and ecological receptors to contaminated soil or downward migration of contaminants to groundwater. Therefore, there is no change to risks estimated in the BRA. Five-year reviews would be required for this alternative. ICs and monitoring are included in Alternative 2. The ICs are described in DOE/RL-2001-41. DOE anticipates that the Hanford Site will remain in Federal ownership in perpetuity. DOE will be responsible for implementation and oversight of the ICs after cleanup is completed. If the end state of the selected remedy cannot support unrestricted human use and unlimited exposure, ICs will be required to maintain human health and the environment. The adequacy and reliability of the controls is very high and is committed to by DOE for the 200-CS-1 OU waste sites. However, the risk for environmental protection at the 216-A-29 Ditch and the 216-S-10 Ditch is deemed unacceptable, and there is no change in risk under this alternative; therefore, Alternative 2 for these waste sites does not meet this criterion under CERCLA.

COCs and COECs identified at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds do not justify remedial actions. Additional RESRAD analysis was performed for the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds using the same input parameters used for the

BRA, except that the soil cover was removed and was not included in the model, to evaluate the risk to industrial workers from radiological contaminants (DOE Order 5400.5) present at these sites. Based on the results of the additional RESRAD analysis, a dose and risk was present for industrial workers assuming that no cover was present at the 216-B-63 Trench; therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained for at least 150 years to protect industrial workers. Because Alternative 2 would provide long-term maintenance of the existing soil cover at the 216-B-63 Trench, this alternative for this waste site meets the long-term effectiveness criterion under CERCLA.

The RESRAD analysis for the 216-S-10 Pond and its analogous waste site 216-S-11 Pond demonstrated that the soil cover is not needed to protect industrial workers from radiological contaminants present at these sites. Therefore, Alternative 2 for the 216-S-10 and 216-S-11 Ponds meets the long-term effectiveness criterion under CERCLA. See Appendix E for further details on the additional RESRAD analysis for the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

7.2.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment would not be implemented with Alternative 2. Reduction of toxicity, mobility, or volume would occur at all of the waste sites in the form of natural attenuation. Natural attenuation is a process that results in a reduction of toxicity, mobility, or volume through the natural radioactive-decay process. Radioactive decay is the only process currently available to eliminate nuclear-particle emissions. The radioactive decay process would influence some of the contaminants identified during characterization. In addition, the heavy metals and Aroclor-1254 (polychlorinated biphenyls) are persistent in the environment and require a long period to attenuate naturally.

As stated previously, EPA acknowledges that natural attenuation can be an appropriate treatment for contaminated soil. Alternative 2 does use source control and monitoring to demonstrate treatment to meet EPA guidance. Based on the risk analysis, no risk drivers are present at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds. Therefore, Alternative 2 meets this criterion under CERCLA for these waste sites where the COCs and COECs do not justify remedial actions.

The 216-A-29 Ditch and the 216-S-10 Ditch have contaminants that pose a risk to the protection of the environment. Because of the concentrations of contaminants and the substantial length of time required for natural attenuation processes to meet PRGs, this alternative for the 216-A-29 Ditch and the 216-S-10 Ditch fails to meet this criterion under CERCLA.

7.2.2.5 Short-Term Effectiveness

7.2.2.5.1 Remediation Worker Risk

For Alternative 2, only minimal short-term worker risks are expected, and these risks are associated with monitoring and maintenance activities. Experienced workers using appropriate safety precautions would conduct these activities. Risks would decrease over time as the chemicals decompose. As such, the risk to workers is qualitatively identified as low. Additionally, active DOE control of the Central Plateau is assumed for the next 50 years, based on future land-use planning. There would not be any short-term risks to the public from existing DOE site-access measures.

7.2.2.5.2 Impact to Environment During Remediation

This alternative would not adversely impact the environment during construction and implementation, because monitoring and maintenance activities are similar to existing ICs that are routinely implemented at these sites. The short-term impacts to the environment are expected to be low.

7.2.2.5.3 Time to Meet the Remedial-Action Objective

In this alternative, RAOs can be fully met only through natural decomposition of contaminants, which can take hundreds of years to achieve and will not meet RAOs in a short-term time frame. An example of a COC that will not naturally decompose in a short-term time frame is cadmium. The cadmium concentration will remain unchanged by any natural decomposition processes in the next few years. This alternative meets the short-term effectiveness criterion under CERCLA for the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds. However, this alternative does not meet the short-term effectiveness criterion under CERCLA for the 216-A-29 Ditch and the 216-S-10 Ditch.

7.2.2.6 Implementability

Alternative 2 could be implemented readily and would not present technical problems. This alternative currently is being implemented through Hanford Site access controls, surface and subsurface radiation-area work and access controls, and the waste-site/radiation-area surveillance and maintenance program.

7.2.2.7 Cost

Cost estimates for Alternative 2 were developed based on existing costs for similar activities currently conducted on the Hanford Site. Details of the cost estimates are presented in Appendix H. Summarized costs for the sites are presented in Table 7-3. This alternative involves costs for activities similar to current activities. These activities involve periodic surveillance of the waste sites for evidence of contamination and biologic intrusion; emplacement of vegetation, herbicide application, or other activities to control deep-rooted plants; control of deep-burrowing animals; maintenance of signs and/or fencing; maintenance of the existing soil cover (including an assumed periodic addition of soil); administrative controls; and site reviews

7.2.3 Detailed Analysis of Alternative 3 – Removal, Treatment, and Disposal

Under Alternative 3, contaminated soil and debris (such as concrete or pipe associated with the sites) would be excavated, removed, treated as necessary to meet disposal-facility waste-acceptance criteria, and transported for disposal at an approved on-site disposal facility that meets human-health, ecological, and groundwater-protection criteria. The approved disposal facility currently is envisioned as the Environmental Restoration Disposal Facility. Based on existing information from the waste sites, soils are not anticipated to require treatment before disposal at the Environmental Restoration Disposal Facility. The depth and volume of soils removed depends on the categories of protection criteria that are exceeded; however, removals generally would be conducted to a maximum depth of 4.6 m (15 ft) or to the depth where the COCs/COECs are greater than the concentration criteria. These depths follow the points of compliance identified in WAC 173-340-745(7), and WAC 173-340-7490. Alternative 3 would remove contaminated waste and soil from waste sites to a depth to meet the RAOs.

After the RI/FS is completed, the proposed plan and ROD documents are prepared and finalized. With completion of these decision documents, the remedial-design and remedial-action phases will begin for the 200-CS-1 OU. This FS has used limited data to estimate the extent of contamination from the COCs and COECs at the waste sites. The limited data are likely to have conservatively estimated the extent of contamination. If Alternative 3 is selected for a waste site, waste minimization activities during remedial action should focus on segregating waste streams during excavation of sites by sampling and analysis for COCs and COECs at the particular site. If the COCs and COECs are below levels of concern, the noncontaminated soil may be stockpiled and backfilled into the excavated portion of the site. The contaminated soil would be removed and disposed of at the Environmental Restoration Disposal Facility. During the remedial-design process, additional soil sampling may be needed to refine excavation dimensions and other engineering-design analyses.

7.2.3.1 Overall Protection of Human Health and the Environment

This alternative generally provides a high degree of overall protection of human health and the environment, because contaminants are removed to meet human-health and environmental-protection criteria. Removal of the contaminants provides for the most flexibility for future land use.

This alternative would provide overall and future protection to humans and the environment in all cases, because the contaminants are excavated and removed from the waste sites. The groundwater would be protected, because COCs are removed to meet the protection criteria. The contaminated soil would be placed in an approved disposal facility, thus meeting final human-health and environmental-protection criteria. The Environmental Restoration Disposal Facility was specifically established for long-term containment, and failure of this alternative is not likely. Residual risks would be at acceptable levels for protection of the environment, because the COCs and COECs are removed. Verification sampling would be conducted to determine that the protection criteria are met by the removal activities.

The risk drivers present at the greatest depths for each of the waste sites determine excavation depths for the removal activities. The following paragraphs summarize the depths of contamination at each of the waste sites, based on the risk drivers present at the waste sites (as shown in Table 3-14). The 216-A-29 Ditch and the 216-S-10 Ditch are discussed in segments because only some of the segments will require soil removal.

216-A-29 Ditch

Segment 1 – No risk drivers are present in Segment 1 of the 216-A-29 Ditch. Therefore, removal of soil from this segment is not justified.

Segment 2 – Risk analysis of Segment 2 of the 216-A-29 Ditch showed that COCs and COECs extend to a maximum depth of approximately 2.0 m (6.5 ft) (See Table 3-14).

216-B-63 Trench – No risk drivers are present at the 216-B-63 Trench (see Table 3-14); therefore, removal of soil from this site is not justified.

216-S-10 Ditch

Covered Portion – Risk drivers are not present in this segment of the 216-S-10 Ditch. Therefore, removal of soil from this segment is not justified.

Uncovered Segment 1 – Risk drivers are not present in this segment of the 216-S-10 Ditch. Therefore, removal of soil from this segment is not justified.

Uncovered Segment 2 – Risk analysis of the uncovered Segment 2 of the 216-S-10 Ditch showed that COECs extend to a maximum depth of approximately 0.9 m (3 ft) (See Table 3-14).

216-S-10 Pond and 216-S-11 Pond – No risk drivers are present at the 216-S-10 Pond and 216-S-11 Pond; therefore, removal of soil from these sites is not justified.

7.2.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

Based on a review of the ARARs presented in Appendix G, several ARARs were identified as applicable to Alternative 3 and were evaluated for each of the waste sites. In addition to the discussion below, a summary of the ARARs for each alternative is presented in Table 7-1.

Chemical-specific ARARs identified for this alternative include those related to national primary drinking water regulations under 40 CFR 141, polychlorinated biphenyl remediation, waste storage, and disposal under 40 CFR 761, and soil cleanup standards for industrial properties under WAC 173-340-745(5)(b). Action-specific ARARs identified for this alternative include those related to closure/postclosure of dangerous waste sites under WAC 173-303-610. These ARARs are not applicable to the sites/segments where the COCs and COECs do not justify remedial actions, which include the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

Alternative 3 involves excavating and removing contaminated soils from the waste sites and disposing of the excavated materials at an approved disposal facility. By removing the contaminated materials from the waste sites and using uncontaminated soils to backfill the excavations, contaminants would be minimized and/or eliminated to the extent necessary to protect the environment. This means that environmental-protection criteria would be achieved and exposure pathways to contaminants would be controlled. Therefore, this alternative would meet the ARARs identified for the 216-A-29 Ditch and the 216-S-10 Ditch.

Other ARARs that would be applicable to this alternative include location-specific ARARs. These ARARs include regulations related to preservation of historical and archaeological sites (*Archeological and Historic Preservation Act* [1960] and *National Historic Preservation Act of 1966*) and endangered and threatened species (*Endangered Species Act of 1973*). It is anticipated that the appropriate agencies would be contacted and the appropriate archaeological and ecological surveys would be completed before any land disturbance or excavation activities begin. Therefore, this alternative would be in compliance with these location-specific ARARs for the 216-A-29 Ditch and the 216-S-10 Ditch.

7.2.3.3 Long-Term Effectiveness and Permanence

Alternative 3 does provide long-term engineered controls by excavating and disposing of contaminated soil to reduce exposures of human and ecological receptors to contaminated soil and downward migration of contaminants to groundwater. By excavating soils in the 200-CS-1 OU to below where the COCs/COECs are located, the residual risks are reduced to levels that are protective of human health and the environment. Five-year reviews may not be required because of the removal of the contamination. Removing the contaminated soil from the 216-A-29 Ditch and the 216-S-10 Ditch would provide a high degree of long-term effectiveness and permanence, because residual contamination would be removed for disposal in an engineered containment facility (i.e., Environmental Restoration Disposal Facility).

ICs and monitoring are included in Alternative 3. As discussed previously for Alternative 2, the implemented ICs would be identified in the ROD and are expected to be selected from the ICs described in DOE/RL-2001-41. The adequacy and reliability of the controls is very high and is committed to by DOE for the 200-CS-1 OU waste sites. Monitoring activities at the 216-A-29 Ditch and the 216-S-10 Ditch would be incorporated into existing monitoring programs. Maintenance activities would include possible vegetation maintenance of the backfilled, excavated areas. Therefore, this alternative for the 216-A-29 Ditch and the 216-S-10 Ditch meets this criterion under CERCLA.

7.2.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 3 does not provide any engineered treatment to reduce toxicity, mobility, or volume. This alternative provides a reduction in the mass of radionuclides and chemical contaminants at the 216-A-29 Ditch and the 216-S-10 Ditch. Treatment is not anticipated before disposal at the Environmental Restoration Disposal Facility. Radiological decay at the Environmental Restoration Disposal Facility ultimately results in reduction of toxicity and volume. Movement of the waste to the Environmental Restoration Disposal Facility would result in reduction of mobility at both the waste sites and the Environmental Restoration

Disposal Facility over their current location. This alternative for the 216-A-29 Ditch and the 216-S-10 Ditch meets this criterion under CERCLA.

7.2.3.5 Short-Term Effectiveness

7.2.3.5.1 Remediation Worker Risk

The levels of contamination at the 216-A-29 Ditch and the 216-S-10 Ditch are not expected to pose a risk to workers when typical practices are followed from a health and safety plan. The Hanford Site has decades of experience in managing and implementing cleanup at this site and for areas much more contaminated than these specific sites. Typical practices should include enclosed excavation equipment and water-based dust suppression. These practices limit the worker risk, with minimal impact on schedule and cost because excavation with dust suppression and health and safety controls has been proven effective in excavating soil sites. There would not be any short-term risks to the public from existing DOE site-access measures.

7.2.3.5.2 Impact to Environment During Remediation

Physical disruption of the waste sites during excavation, increased human activity, and noise affect local biological resources. However, the waste sites are located within historically disturbed industrial areas. Potential animal intrusion and biological uptake also are issues that will require control of open excavations and exposed contaminated soils at the end of each day. This control could be accomplished through placement of covers or fixatives. Areas of disturbed surface are provided below. Overall, there should not be an adverse environmental impact from this alternative.

Segment 2 of the 216-A-29 Ditch – The surface area disturbed during excavation of this site will be approximately 0.5 ha (1.2 a.).

Uncovered Segment 2 of the 216-S-10 Ditch – The surface area disturbed during excavation of this site will be approximately 0.5 ha (1.2 a.).

Transportation activities on the Central Plateau would increase as a result of bringing construction equipment to the site, transporting contaminated soils to the Environmental Restoration Disposal Facility, and bringing clean fill to the excavated sites. Because the Environmental Restoration Disposal Facility is located on site, minimal environmental impact is associated with the transport of waste. Air monitoring around the waste sites would be used to monitor potential air releases (e.g., waste or fill-material particulates) that could affect the public and the environment.

7.2.3.5.3 Time to Achieve the Remedial-Action Objective

This alternative prevents the risk to human or ecological receptors by moving the contaminated soils to the Environmental Restoration Disposal Facility for disposal to meet RAOs. Construction and waste-excavation activities are estimated for each 200-CS-1 OU waste site below.

216-A-29 Ditch – Remediation of this site would take approximately two months.

216-S-10 Ditch – Remediation of this waste site would take approximately two months.

This alternative for the 216-A-29 Ditch and the 216-S-10 Ditch meets this criterion under CERCLA.

7.2.3.6 Implementability

Excavation is a proven and implementable technology used to remove wastes. The expected excavations will not require the use of more sophisticated excavating equipment or techniques, such as approach ramps, shoring, or extensive removal of clean material, to provide safe side slopes, etc. In the case that aboveground structures (e.g., vent pipes, concrete structures) are encountered, they would be removed along with the waste-site soil covers and contaminated soils. To provide safe side slopes, every 0.3 m (1 ft) of excavation would require 0.5 m (1.5 ft) of side slope for a 1:1.5 vertical to horizontal ratio. It is assumed for this FS that Site-specific interferences or structures will not be addressed at this time but will be addressed during remedial design.

Segment 2 of the 216-A-29 Ditch – The excavation would be to a depth of about 2.6 m (8.5 ft) bgs for approximately 490 m (1,606 ft). Excavating the site to remove the COCs/COECs using a side slope for a 1:1.5 vertical to horizontal ratio would result in approximately 7,230 m^3 (9,453 yd^3) of contaminated soil being removed and sent to the Environmental Restoration Disposal Facility.

Uncovered Segment 2 of the 216-S-10 Ditch – The excavation would be to a depth of about 4.6 m (15 ft) bgs for approximately 310 m (1,015 ft). Excavating the site to remove the COCs/COECs using a side slope for a 1:1.5 vertical to horizontal ratio would result in approximately 12,230 m^3 (15,996 yd^3) of contaminated soil being removed and sent to the Environmental Restoration Disposal Facility.

Coordination with other agencies and local governments would be necessary after approval of the alternative. Excavation and disposal would require coordination with State agencies to assess matters relative to storm-water control and the potential for radioactive air emissions.

7.2.3.7 Cost

Costs include mobilizing personnel and equipment; monitoring, sampling, and analysis; excavating; disposing of the waste at the Environmental Restoration Disposal Facility; backfilling with onsite resources and additional backfilling from a local stockpile; revegetating; and performing prime-contractor oversight.

Costs are based on the use of standard excavation equipment (e.g., hydraulic excavators, front-end loaders, tractor-trailers). The costs are based on the assumption that a subcontractor would do the work, with oversight performed by prime-contractor personnel. Details of the cost estimates are presented in Appendix H. Summarized costs for the sites are presented in Table 7-4.

7.2.4 Detailed Analysis of Alternative 4 – Engineered Barrier

Alternative 4 uses engineered barriers or caps to (1) cover the contaminated waste sites, (2) control the amount of water that infiltrates into the contaminated media as a means of protecting groundwater, (3) prevent intrusion by human and ecological receptors as a means of protecting human health and the environment, and (4) limit wind and water erosion. Two types of engineered barriers or caps were analyzed as part of this alternative, which include an ET Monofill Barrier and a RCRA Subtitle C cap.

After completion of the RI/FS, the proposed plan and ROD documents are prepared and finalized. With completion of these decision documents, the remedial-design and remedial-action phases will begin for the 200-CS-1 OU. This FS has used limited data to estimate the extent of contamination at the waste sites. The limited data are likely to have conservatively estimated the extent of contamination. If Alternative 4 is selected for a waste site, the waste-minimization activities during remedial action should focus on sampling and analysis of the COCs/COECs to confirm the boundaries of the waste-soil site to minimize the area of the barrier. During the remedial-design process, additional soil sampling may be needed to refine excavation dimensions and other engineering-design analyses.

The following sections present a detailed analysis of Alternative 4 against the evaluation criteria.

7.2.4.1 Overall Protection of Human Health and the Environment

The type of barrier or cap used for a waste site is dependent on the risks present at the site. The ET Monofill Barrier includes components that address human-health, ecological, and groundwater protection and is the preferred capping technology for the 200-CS-1 OU. The RCRA Subtitle C cap does not address the ecological-intrusion performance requirement. Because ecological risks are present at two of the waste sites, overall protection criteria were analyzed for these sites, assuming that an ET Monofill Barrier would be used. This barrier incorporates a biobarrier layer that prevents ecological intrusion into the waste.

In addition, the use of an engineered barrier or cap would require an assessment of the lateral extent of contamination during the confirmatory and/or remedial-design sampling phases to properly size the cap to ensure containment. Some degree of oversizing of the barrier beyond the waste-zone footprint is expected and, for the purpose of this FS, an overlap of 6.1 m (20 ft) is assumed. It is assumed for this FS that site-specific interferences or structures will not be addressed at this time but will be addressed during remedial design.

A more detailed analysis of overall protection and barrier/cap size for each waste site is presented below.

<u>216-A-29 Ditch</u>

Segment 1 – There are no risk drivers present at the 216-A-29 Ditch. Therefore, the use of a barrier for this segment is not justified.

Segment 2 – Risk analysis of Segment 2 of the 216-A-29 Ditch showed that ecological and groundwater-protection risk drivers are present at this site (See Table 3-14). Therefore, the use of an ET Monofill Barrier would be appropriate and would provide overall protection of the environment. The estimated capping dimensions for this segment of the 216-A-29 Ditch include an approximate length of 504 m (1,652 ft) and a width of 26 m (85 ft).

216-B-63 Trench – There are no risk drivers present at the 216-B-63 Trench (see Table 3-14); therefore, the use of a barrier for this segment is not justified.

216-S-10 Ditch

Covered Portion – There are no risk drivers present in this segment of the 216-S-10 Ditch. Therefore, the use of a barrier for this segment is not justified.

Uncovered Segment 1 – There are no risk drivers present in this segment of the 216-S-10 Ditch. Therefore, the use of a barrier for this segment is not justified.

Uncovered Segment 2 – Risk analysis of the uncovered Segment 2 of the 216-S-10 Ditch showed that ecological and groundwater-protection risk drivers are present (See Table 3-14). Therefore, the use of an ET Monofill Barrier would be appropriate and would provide overall protection of the environment. The estimated capping dimensions for this site include an approximate length of 320 m (1,049 ft) and a width of 26 m (85 ft).

216-S-10 Pond and 216-S-11 Pond – There are no risk drivers present at the 216-S-10 Pond and 216-S-11 Pond; therefore, the use of a barrier at these sites is not justified.

7.2.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

Based on a review of the ARARs presented in Appendix G, several ARARs were identified as applicable to Alternative 4 and were evaluated for each of the waste sites. In addition to the discussion below, a summary of the ARARs for each alternative is presented in Table 7-1.

Chemical-specific ARARs identified for this alternative include those related to national primary drinking water regulations under 40 CFR 141, polychlorinated biphenyl remediation, waste storage, and disposal under 40 CFR 761, and soil cleanup standards for industrial properties under WAC 173-340-745(5). Action-specific ARARs identified for this alternative include those related to closure/postclosure of dangerous waste sites and dangerous waste landfills under WAC 173-303-610 and WAC 173-303-665, respectively. These ARARs are not applicable to the sites/segments where no risk drivers are present, which include the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

Alternative 4 involves leaving the contaminated waste in place and constructing an engineered surface barrier over the waste to provide protection of human health and the environment. Alternative 4 would comply with all ARARs for the waste sites by breaking the pathways for exposure and emplacing caps that meet the intent of the regulations. In addition to the cap, this alternative includes IC elements such as land-use restrictions and groundwater monitoring.

Other ARARs that would be applicable to this alternative include location-specific ARARs. These ARARs include regulations related to preservation of historical and archaeological sites (*Archeological and Historic Preservation Act* [1960] and *National Historic Preservation Act of 1966*) and endangered and threatened species (*Endangered Species Act of 1973*). It is anticipated that the appropriate agencies would be contacted and the appropriate archaeological and ecological surveys would be completed before any land disturbance or excavation activities began. Therefore, this alternative would be in compliance with these location-specific ARARs for the 216-A-29 Ditch and the 216-S-10 Ditch.

7.2.4.3 Long-Term Effectiveness and Permanence

Alternative 4 would reduce risks to human health and the environment to acceptable levels by breaking exposure pathways to human and ecological receptors from contaminated soil. Further, this alternative will reduce surface infiltration into the 216-A-29 Ditch and the 216-S-10 Ditch and subsequently reduce the downward migration of contaminants to groundwater. Chemicals and radionuclides left in place at the waste sites would be physically separated from receptors by the thickness of the cap and by the additional thickness of the existing soil covers. Because contaminants at the waste sites have the potential to impact ecological receptors, caps would be designed to include a biobarrier over the waste site. The biobarrier would be constructed out of materials that would inhibit or eliminate exposures to ecological receptors or mobilization of contaminated soil by deeply rooting plants or burrowing animals. The monofill barrier cover would extend beyond the estimated extent of soil contamination at Segment 2 of the 216-A-29 Ditch and the uncovered Segment 2 of the 216-S-10 Ditch on all sides to ensure that contaminated soil is adequately covered. Five-year reviews would be required, because the contaminants are left in place underneath the monofill barrier.

Monofill barriers are a well-demonstrated technology and will meet the performance specifications (RAOs). ICs and monitoring are included in Alternative 4. As discussed previously for Alternative 2, ICs are included as described in DOE/RL-2001-41. The adequacy and reliability of the controls is very high and is committed to by DOE for the 200-CS-1 OU waste sites. A significant amount of risk attenuates during the ICs period. Therefore, failure of the caps in later years would be associated with lower risks than at present. Additionally, the five-year reviews required for sites with contaminants above PRGs would serve to evaluate the effectiveness and reliability of the caps, and adjustments in maintenance activities could be instituted to help prevent failure.

The long-term effectiveness depends on the proper construction and maintenance of the barrier and associated ICs throughout the ICs time frame to prevent exposure to potential receptors. Maintenance activities would include erosion repairs and possible vegetation maintenance. Subsidence is not considered a major factor in maintenance activities for these waste sites. Failure of the cap is unlikely if maintenance and IC activities continue. Caps would be designed and constructed to account for the appropriate time frame to reach acceptable risk levels and to minimize maintenance requirements and impacts from a lapse in the ICs. During construction, the barrier and surrounding disturbed area would be revegetated to further enhance ET, limit erosion, and blend the site area into the surrounding landscape.

Therefore, this alternative for the 216-A-29 Ditch and the 216-S-10 Ditch meets this criterion under CERCLA.

7.2.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of toxicity, mobility, or volume would occur in the form of reduced infiltration through the 216-A-29 Ditch and the 216-S-10 Ditch and natural attenuation at these waste sites. The capping alternative reduces infiltration through the waste by storing precipitation that is used by the vegetative cover on top of the monofill barrier. By reducing infiltration at these sites, this alternative reduces the mobility of all the contaminants in the soil.

7.2.4.5 Short-Term Effectiveness

7.2.4.5.1 Remediation Worker Risk

For Alternative 4, only minimal short-term worker risks are expected, and these risks are associated with initial groundbreaking construction activities. As soon as the initial materials are placed over Segment 2 of the 216-A-29 Ditch and the uncovered Segment 2 of the 216-S-10 Ditch, short-term worker risks decrease when typical practices are followed from a health and safety plan. Typical practices should include water-based dust suppression. These practices limit the worker risk, with minimal impact on schedule and cost, because soil placement with dust suppression and health and safety controls has been proven effective in constructing barriers at similar soil-contamination sites. The capping alternative would not require excavation of contaminated soils, so the risks to workers primarily would be associated with general construction activities at the borrow sites and placement of the cap. Air monitoring would address potential air releases (e.g., barrier-material particulates) that could affect the public during construction of the surface barriers. There would not be any short-term risks to the public because of existing DOE site-access measures.

7.2.4.5.2 Impact to Environment During Remediation

Physical disruption of the waste sites during cap construction and increased human activity and noise affect local biological resources. However, the waste sites are located within historically disturbed industrial areas, and these sites currently are poor wildlife habitats. As such, no adverse environmental impacts would occur.

Segment 2 of the 216-A-29 Ditch – The surface area disturbed during barrier construction at this site will be approximately 1.3 ha (3.2 a.).

Uncovered Segment 2 of the 216-S-10 Ditch – The surface area disturbed during barrier construction at this site will be approximately 0.81 ha (2 a.).

7.2.4.5.3 Time to Meet the Remedial-Action Objectives

This alternative reduces risk to human or ecological receptors by capping the contaminated soils to provide a barrier to reduce exposure for meeting RAOs. Construction activities are estimated for each 200-CS-1 OU waste site below.

216-A-29 Ditch – Construction of the cap for this waste site would take approximately two months.

216-S-10 Ditch – Construction of the cap for this waste site would take approximately two months.

This alternative for the 216-A-29 Ditch and the 216-S-10 Ditch meets this criterion under CERCLA.

7.2.4.6 Implementability

The capping alternative is considered implementable at all waste sites. The main design feature would be to store water during the wet periods and release it back to indigenous vegetation during prolonged periods of dry weather. The monofill barrier has been used at the Hanford Site and is straightforward to construct and maintain. The existing soil covers over the waste sites would be considered a part of the overall design to minimize the cost of materials and to minimize the impact to visual aesthetics.

Construction of the caps would follow standard procedures that have been thoroughly field tested. The caps likely would require minor repair and possibly replacement during the restoration time frame. Monitoring the continued integrity of the caps would be accomplished through visual inspection and would be supplemented with groundwater sampling. Implementation of the capping alternative would require additional design data (e.g., ground-penetrating radar) and possibly confirmatory sampling, because existing data may not be adequate for determining the lateral extent of the caps.

Gravel, sand, and silt/loam soil used for the caps would be transported from borrow areas located on or near the Hanford Site. Anticipated volumes of these materials are identified in Appendix H. Area C currently is designated as a silt-borrow location; the area has a large volume of fine-grained material. Other locations have not yet been determined. Soil most likely would come from near the waste sites or from Pit 30, which is located between the 200 East and 200 West Areas. Borrow material may occur in environmentally sensitive areas; obtaining sufficient capping material, especially for a multilayered cap, could affect areas of ecological significance and is a consideration in evaluating the relative risk reduction gained by installing the cap. Materials such as rip-rap that may be used in the cap construction could be obtained on the Hanford Site or could be purchased from local dealers.

Capping materials hauled to the Central Plateau from borrow areas and gravel pits within the Hanford Site would increase heavy equipment use and transportation activities at the sites. However, radioactive or hazardous waste would not have to be hauled from the Site.

Segment 2 of the 216-A-29 Ditch – An ET monofill cap would be installed at this segment of the 216-A-29 Ditch. The cap would be built to cover 1.3 ha (3.2 a.) of the ditch.

Uncovered Segment 2 of the 216-S-10 Ditch – An ET monofill cap would be installed at this segment of the 216-S-10 Ditch. The cap would be built to cover 0.81 ha (2 a.) of the ditch.

7.2.4.7 Cost

Costs, shown in Table 7-5, include stabilization of the existing site; excavation or import, transportation, and placement of capping material; compaction of the cap; prime-contractor oversight; and confirmatory sampling. Costs are based on the use of standard equipment (e.g., hydraulic excavators, front-end loaders, dozers) and assume that a subcontractor would do the work, with oversight performed by the prime contractor. The operations and maintenance costs include site inspection/surveillance, periodic radiation-site surveys of surface soil, biotic control, maintenance of signs and markers, cover maintenance, and site reviews. Details of the cost estimates are presented in Appendix H. Summarized costs for the sites are presented in Table 7-5.

7.3 NEPA VALUES EVALUATION

The NEPA process is intended to help Federal agencies make decisions that are based on understanding environmental consequences and then take actions that protect, restore, and enhance the environment. DOE secretarial policies and DOE O 451.1B require that CERCLA documents incorporate NEPA values, such as analysis of cumulative, offsite, ecological, and socioeconomic impacts to the extent practicable, in lieu of preparing separate NEPA documentation for CERCLA activities.

7.3.1 Description of NEPA Values

Several of the CERCLA evaluation criteria involve consideration of environmental resources, but the emphasis is frequently directed at the potential effects of chemical contaminants on living organisms. The NEPA regulations (40 CFR 1502.16, "Environmental Impact Statement," "Environmental Consequences") specify evaluation of the environmental consequences of proposed alternatives. These consequences include potential effects on transportation resources, air quality, and cultural and historical resources; noise; visual, and aesthetic effects; environmental justice; and the socioeconomic aspects of implementation. The NEPA process also involves consideration of several issues such as cumulative impacts (direct and indirect), mitigation of adversely impacted resources, and the irreversible and irretrievable commitment of resources.

NEPA-related resources and values that the DOE has considered in this evaluation include the following.

- <u>Transportation impacts</u>. This value considers impacts of the proposed remedial action on local traffic (e.g., traffic at the Hanford Site) and traffic in the surrounding region. Transportation impacts are considered in part under the CERCLA criteria of short-term effectiveness or implementability.

- <u>Air quality</u>. This value considers potential air quality concerns associated with emissions generated during the proposed remedial actions.

- Natural, cultural, and historical resources. This value considers impacts of the proposed remedial actions on wildlife, wildlife habitat, archeological sites and artifacts, and historically significant properties on the Central Plateau.

- Noise, visual, and aesthetic effects. This value considers increases in noise levels or impaired visual or aesthetic values during or after the proposed remedial actions.

- Socioeconomic impacts. This value considers impacts pertaining to employment, income, other services (e.g., water and power utilities), and the effect on the availability of services and materials of implementing the proposed remedial actions.

- Environmental justice. Environmental justice, as mandated by Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, refers to fair treatment of humans of all races, cultures, and income levels with respect to laws, policies, and government actions. This value considers whether the proposed remedial actions would have inappropriately or disproportionately high and adverse human-health or environmental effects on minority or low-income populations.

- Cumulative impacts (direct and indirect). This value considers whether the proposed remedial actions could have cumulative impacts on human health or the environment when considered together with other activities on the Central Plateau, at the Hanford Site, or in the region.

- Mitigation. If adverse impacts cannot be avoided, remedial-action planning should minimize them to the extent practicable. This value identifies required mitigation activities.

- Irreversible and irretrievable commitment of resources. This value evaluates the use of nonrenewable resources for the proposed remedial actions and the effects that resource consumption would have on future generations. When a resource (e.g., energy, minerals, water, wetland) is used or destroyed and cannot be replaced within a reasonable amount of time, its use is considered irreversible.

7.3.2 Detailed Evaluations of NEPA

7.3.2.1 Transportation Impacts

Implementation of remedial action at the waste sites likely would have some short-term impacts on local traffic and traffic in the surrounding region. For Alternative 4, impacts would result from hauling cover material to the waste-site areas. For Alternative 3, impacts would result from hauling waste to the Environmental Restoration Disposal Facility and hauling clean fill to the waste sites. For Alternatives 3 and 4, impacts could be expected from increased traffic bringing supplies, equipment, and workers to the sites. To mitigate these potential impacts, a transportation safety analysis would be performed before any transport activities began. The analysis would identify the need for specific precautions (e.g., road closures, preferred hauling times, staggered work shifts) to be taken as necessary. Increases in the workforce traffic related to waste treatment would be expected to be minor.

7.3.2.2 Air Quality

No current air-quality impacts are associated with Alternatives 1 and 2; however, potential impacts to air quality could be associated with plant or animal uptake of contaminants and wind dispersion. Potential near-term impacts to air quality associated with Alternatives 3 and 4 are expected to be minor and could be mitigated through appropriate engineering controls.

Potential air-quality impacts primarily would be associated with fugitive dust during site preparation, structure demolition, excavation, placement of backfill or barriers, and revegetation activities. Dust suppression (using water and water treated with soil fixatives) would be used to control visible fugitive dust, so neither local nor regional air quality is expected to be affected. Routine emissions from vehicles would occur.

7.3.2.3 Natural, Cultural, and Historical Resources

In all cases, remediation will be performed on sites that have been disturbed by industrial activities. Therefore, although cultural resources could be encountered with Alternatives 3 and 4 during the excavation and construction of staging areas, the probability is low. To ensure that impacts to cultural resources are avoided and/or mitigated, a cultural-resource mitigation plan would be established before remediation was begun. If cultural resources were encountered during excavation, work would be stopped in the area, and unanticipated and inadvertent discovery procedures would be followed pursuant to DOE/RL-98-10, *Hanford Cultural Resource Management Plan.*

Some short-term adverse impacts to natural resources (e.g., local wildlife) could occur during the construction and implementation phases of remedial action. Ecological surveys would be performed to identify the species present and the special precautions that should be taken to minimize adverse impacts.

7.3.2.4 Noise, Visual, and Aesthetic Effects

Alternatives 1 and 2 would have little to no impact on current noise, visual, or aesthetic site characteristics. Alternative 3 would increase noise levels and impair visual values, but the impacts would be short term during remedial actions and ultimately would improve the aesthetics by removing any remaining site structures. Likewise, Alternative 4 would increase noise levels and impair visual values in the short term during construction of the cap. These alternatives also could have some long-term visual and aesthetic impacts, both positive and negative. Positive impacts would result from the removal of aboveground site structures. Negative impacts would be associated with the visibility and aesthetics of the caps over large distances if they are not contoured to blend in with the surrounding area. Aesthetically, given the past disturbance in the 200 Areas and on the Central Plateau, no impacts would be expected from the alternatives

7.3.2.5 Socioeconomic Impacts

Alternative 1 would have no socioeconomic impacts. The other alternatives would have some positive socioeconomic impacts related to the employment opportunities that would occur during the life of the remedial-action project. The labor force required to implement remedial action would be drawn from current Hanford Site contractors and the local labor force, so the socioeconomic impacts would be expected to be minimal.

7.3.2.6 Environmental Justice

Under Alternative 3, environmental justice issues would not be a concern, because future surface uses on the Central Plateau would not be restricted beyond the Central Plateau-wide restrictions. Under Alternatives 1, 2, and 4, environmental justice impacts would be minimal, because future-use restrictions would pertain to only a small percentage of the Central Plateau, and the Central Plateau still would be under active waste-management industrial land use.

7.3.2.7 Irreversible and Irretrievable Commitment of Resources

Alternatives 3 and 4 would require some irreversible or irretrievable commitment of natural resources. All of the alternatives with the exception of Alternative 1 would result in some land-use loss. Alternatives 3 and 4 would require additional soils, including materials that could come from ecologically sensitive areas, and some energy resources. They would require a commitment of resources in the form of land-use loss in the waste-site areas until RAOs and goals were met through the natural-attenuation process. The amount of land-use loss would vary among alternatives. Alternative 2 generally would require land-use loss of the entire site surface and subsurface for the necessary attenuation period to meet RAOs. Alternative 3 generally would allow land use from the ground surface to a depth of 4.6 m (15 ft) bgs or greater following the completion and regulatory acceptance of remedial activities. Alternative 4 would allow surface use of the sites, but would not allow any subsurface site use until the end of the necessary attenuation period to meet RAOs. This use would be limited based on potential impacts to surface-barrier integrity.

For Alternative 3, the Environmental Restoration Disposal Facility would not need to be expanded to accommodate the additional waste. The waste volumes from the aboveground structure demolition in Alternatives 3 and 4 are relatively small and are not anticipated to specifically require additional Environmental Restoration Disposal Facility capacity.

Alternatives 3 and 4 would require an irretrievable and irreversible commitment of resources in the form of geologic materials and petroleum products (e.g., diesel fuel, gasoline). With Alternative 3, excavated material would be replaced with a stockpile of clean-soil cover removed from the site, as well as clean sand and gravel fill from onsite borrow pits (e.g., Area C borrow area). The sand and gravel for the surface-barrier alternative would come from nearby borrow pits, but the silt would need to come either from the Fitzner-Eberhardt Arid Lands Ecology Reserve or from offsite. Rip-rap or other armoring materials needed to provide intrusion protection likely would come from offsite.

7.3.2.8 Cumulative Impacts

The proposed RAOs could have impacts when considered together with impacts from past and foreseeable future actions at and near the Hanford Site. Authorized current and future activities include soil and groundwater remediation; waste management and treatment (e.g., tank farms, the Waste Treatment Plant); and surveillance, maintenance, decontamination, and decommissioning of facilities. Other Hanford Site activities that might be ongoing during remedial action at the Central Plateau waste sites include deactivation and decontamination of reprocessing facilities and operation of the Energy Northwest reactor. Activities near the Hanford Site include a privately owned radioactive and mixed-waste treatment facility, a commercial-fuel manufacturer, a commercial low-level radioactive-waste disposal site, and a titanium reprocessing plant.

The proposed remediation alternatives would have minimal impacts on transportation; air quality; and natural, cultural, and historical resources. Noise, visual and aesthetic effects, and socioeconomic impacts also would be minimal. Therefore, cumulative impacts with respect to these values are expected to be insignificant. The most notable area for cumulative impacts is with respect to the irretrievable and irreversible commitment of resources. All of the proposed alternatives except Alternative 1 would require long-term land-use restrictions.

To varying levels, Alternatives 2, 3, and 4 would result in the loss of some land uses on the Central Plateau, but the cumulative impacts with respect to loss of land use are not expected to be significant. Alternative 3 also would require a commitment of land use as a result of the Environmental Restoration Disposal Facility expansion on the Central Plateau. This would be in addition to numerous other Hanford Site projects that would commit land use on the Central Plateau.

Under Alternatives 3 and 4, cumulative impacts also would occur with respect to the irretrievable and irreversible commitment of geologic resources. The Central Plateau waste sites constitute only a portion of the total actions requiring material for barriers and backfill at the Hanford Site. The total quantity of geologic materials required for other Hanford Site actions currently is being identified (BHI-01551) and may be subject to a separate NEPA evaluation. Currently, a borrow area (Area C) is being developed west of Route 240 to support capping activities planned at the U Plant area.

7.3.2.9 Mitigation

Alternative 1 would not include mitigation. Mitigation measures under Alternative 2 would include surveillance, physical controls, and potential interim remedies. Mitigation measures taken under Alternatives 3 and 4 would include dust suppression, stockpiling clean topsoil for reuse, minimizing the size of construction areas, and planning activities to avoid nesting and breeding cycles of birds and mammals.

7.3.2.10 Summary of NEPA Evaluation

Remedial actions at the Central Plateau waste sites would result in some impacts to public health and the environment. However, the overall environmental impacts under normal operating conditions would not be very large, nor would they vary greatly among the remedial alternatives.

Table 7-1. Analysis of ARARs for Alternatives 1 through 4. (3 Pages)

Applicable or Relevant and Appropriate Requirements	Site	Alternative 1, No Action	Alternative 2, Natural Attenuation/Institutional Controls	Alternative 3, Removal, Treatment and Disposal	Alternative 4, Containment Using Surface Barriers
40 CFR 141.61; 40 CFR 141.62; and 40 CFR 141.66	216-A-29 Ditch	Will not meet – Alternative does not provide protection of groundwater.	Will not meet – Alternative does not provide protection of groundwater.	Will Meet	Will Meet
	216-B-63 Trench	N/A – COCs and COECs present at this waste site do not justify remedial actions.	N/A – COCs and COECs present at this waste site do not justify remedial actions.	N/A – COCs and COECs present at this waste site do not justify remedial actions.	N/A – COCs and COECs present at this waste site do not justify remedial actions.
	216-S-10 Ditch	Will not meet – Alternative does not provide protection of groundwater.	Will not meet – Alternative does not provide protection of groundwater.	Will Meet	Will Meet
	216-S-10 and 216-S-11 Ponds	N/A – COCs and COECs present at this waste site do not justify remedial actions.	N/A – COCs and COECs present at this waste site do not justify remedial actions.	N/A – COCs and COECs present at this waste site do not justify remedial actions.	N/A – COCs and COECs present at this waste site do not justify remedial actions.
40 CFR 761.50(b)(3); 40 CFR 761.50(b)(4); 40 CFR 761.50(b)(7); and 40 CFR 761.50(c)	216-A-29 Ditch	Will not meet – Alternative will not meet PCB remediation waste clean-up criteria.	Will not meet – Alternative will not meet PCB remediation waste clean-up criteria.	Will Meet	Will Meet
	216-B-63 Trench	N/A – PCBs are not present at this waste site.	N/A – PCBs are not present at this waste site.	N/A – PCBs are not present at this waste site.	N/A – PCBs are not present at this waste site.
	216-S-10 Ditch	Will not meet – Alternative will not meet PCB remediation waste clean-up criteria.	Will not meet – Alternative will not meet PCB remediation waste clean-up criteria.	Will Meet	Will Meet
	216-S-10 and 216-S-11 Ponds	N/A – PCBs are not present at this waste site.	N/A – PCBs are not present at this waste site.	N/A – PCBs are not present at this waste site.	N/A – PCBs are not present at this waste site.

Table 7-1. Analysis of ARARs for Alternatives 1 through 4. (3 Pages)

Applicable or Relevant and Appropriate Requirements	Site	Alternative 1, No Action	Alternative 2, Natural Attenuation/Institutional Controls	Alternative 3, Removal, Treatment and Disposal	Alternative 4, Containment Using Surface Barriers
WAC 173-303-610	216-A-29 Ditch	Will not meet – Alternative does not minimize or eliminate contaminants to the extent necessary to protect the environment.	Will not meet – Alternative does not minimize or eliminate contaminants to the extent necessary to protect the environment.	Will Meet	Will Meet
	216-B-63 Trench	N/A	N/A	N/A	N/A
	216-S-10 Ditch	Will not meet – Alternative does not minimize or eliminate contaminants to the extent necessary to protect the environment.	Will not meet – Alternative does not minimize or eliminate contaminants to the extent necessary to protect the environment.	Will Meet	Will Meet
	216-S-10 and 216-S-11 Ponds	N/A	N/A	N/A	N/A
WAC 173-303-665	216-A-29 Ditch	Will Not Meet	Will Not Meet	N/A	Will Meet
	216-B-63 Trench	N/A	N/A	N/A	N/A
	216-S-10 Ditch	Will Not Meet	Will Not Meet	N/A	Will Meet
	216-S-10 and 216-S-11 Ponds	N/A	N/A	N/A	N/A

Table 7-1. Analysis of ARARs for Alternatives 1 through 4. (3 Pages)

Applicable or Relevant and Appropriate Requirements	Site	Alternative 1, No Action	Alternative 2, Natural Attenuation/Institutional Controls	Alternative 3, Removal, Treatment and Disposal	Alternative 4, Containment Using Surface Barriers
WAC 173-340-745(5)	216-A-29 Ditch	Will not meet – Ecological and groundwater protection criteria will not be achieved.	Will not meet – Ecological and groundwater protection criteria will not be achieved.	Will Meet	Will Meet
	216-B-63 Trench	N/A	N/A	N/A	N/A
	216-S-10 Ditch	Will not meet – Ecological and groundwater protection criteria will not be achieved.	Will not meet – Ecological and groundwater protection criteria will not be achieved.	Will Meet	Will Meet
	216-S-10 and 216-S-11 Ponds	N/A	N/A	N/A	N/A

40 CFR 141.61, "Maximum Contaminant Levels for Organic Contaminants."
40 CFR 141.62, "Maximum Contaminant Levels for Inorganic Contaminants."
40 CFR 141.66, "Maximum Contaminant Levels for Radionuclides."
40 CFR 761.50(b)(3), "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," "Applicability," "PCB Waste," "PCB Remediation Waste."
40 CFR 761.50(b)(4), "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," "Applicability," "PCB Waste," "PCB Bulk Product Waste."
40 CFR 761.50(b)(7), "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," "Applicability," "PCB Waste," "PCB/Radioactive Waste."
40 CFR 761.50(c), "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," "Applicability," "Storage for Disposal."
WAC 173-303-610, "Closure and Post-Closure."
WAC 173-303-665, "Landfills."
WAC 173-340-745(5), "Method C Industrial Soil Cleanup Levels."

COC = contaminant of concern.
N/A = not applicable.
PCB = polychlorinated biphenyl.

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Table 7-2. Detailed Analysis Summary for Alternative 1 – No-Action. (2 Pages)

Waste Site	Threshold Criteria		Balancing Criteria				
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Present Worth Cost in Thousands
Representative Waste Sites							
216-A-29 Ditch	Not protective of the environment because contaminants are above risk-based protection criteria and remain in-place with no barrier.	Does not comply.	Fails to meet criteria because there is no change in risk and no controls are implemented.	Fails to meet criteria because there is no treatment or monitoring to demonstrate natural attenuation.	Fails to meet criteria because the time until RAOs are met is excessive.	Readily implementable.	$0
216-B-63 Trench	Fails to meet criteria because existing soil cover will degrade and, based on RESRAD modeling, assuming no soil cover exists, radiological contaminants would pose an unacceptable risk to industrial workers.	The identified ARARs are not applicable to this site.	Fails to meet criteria because existing soil cover will degrade and, based on RESRAD modeling, assuming no soil cover exists, radiological contaminants would pose an unacceptable risk to industrial workers.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Readily implementable.	$0
216-S-10 Ditch	Not protective of the environment because contaminants are above risk-based protection criteria and remain in place with no barrier.	Does not comply.	Fails to meet criteria because there is no change in risk and no controls are implemented.	Fails to meet criteria because there is no treatment or monitoring to demonstrate natural attenuation.	Fails to meet criteria because the time until RAOs are met is excessive.	Readily implementable.	$0
216-S-10 Pond	Meets this criterion because no risk drivers are present at this site.	The identified ARARs are not applicable to this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Readily implementable.	$0

Table 7-2. Detailed Analysis Summary for Alternative 1 – No-Action. (2 Pages)

Waste Site	**Threshold Criteria**		**Balancing Criteria**				
Waste Site	**Overall Protection of Human Health and the Environment**	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Present Worth Cost in Thousands**
Waste Site Analogous to 216-S-10 Pond							
216-S-11 Pond	Meets this criterion because no risk drivers are present at this site.	The identified ARARs are not applicable to this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Readily implementable.	$0

ARAR = applicable or relevant and appropriate requirement.
COC = contaminant of concern.
DOE = U.S. Department of Energy.
N/A = not applicable.
RAO = remedial-action alternative.
RESRAD = RESidual RADioactivity (dose model).

Table 7-3. Detailed Analysis Summary for Alternative 2 – Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls. (2 Pages)

Waste Site	Threshold Criteria		Balancing Criteria				
	Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implemen-tability**	**Present Worth Cost in Thousands**
Representative Waste Sites							
216-A-29 Ditch	Not protective of the environment because contaminants are above risk-based protection criteria and remain in-place with no barrier.	Does not comply.	Fails to meet criteria because there is no change in risk even though adequate controls are implemented.	Fails to meet criteria because reduction through natural attenuation takes too long to reduce toxicity effectively.	Fails to meet criteria because the time until RAOs are met is excessive.	Readily implementable, including feasible monitoring approach.	\$1,057
216-B-63 Trench	Meets this criterion because Alternative 2 would provide long-term maintenance of the existing soil cover and would prevent exposure of industrial workers to unacceptable risk.	The identified ARARs are not applicable to this site.	Meets this criterion because Alternative 2 would provide long-term maintenance of the existing soil cover and would prevent exposure of industrial workers to unacceptable risk.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Readily implementable, including feasible monitoring approach.	\$1,064
216-S-10 Ditch	Not protective of the environment because contaminants are above risk-based protection criteria and remain in place with no barrier.	Does not comply.	Fails to meet criteria because there is no change in risk even though adequate controls are implemented.	Fails to meet criteria because reduction through natural attenuation takes too long to reduce toxicity effectively.	Fails to meet criteria because the time until RAOs are met is excessive.	Readily implementable, including feasible monitoring approach.	\$1,066

Table 7-3. Detailed Analysis Summary for Alternative 2 – Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls. (2 Pages)

Waste Site	Threshold Criteria		Balancing Criteria				
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Present Worth Cost in Thousands
216-S-10 Pond	Meets this criterion. Implementation of Alternative 2 at this waste site is not justifiable because no risk drivers are present at this site.	The identified ARARs are not applicable to this site.	Meets this criterion. Implementation of Alternative 2 at this waste site is not justifiable because no risk drivers are present at this site.	Meets this criterion. Implementation of Alternative 2 at this waste site is not justifiable because no risk drivers are present at this site.	Meets this criterion. Implementation of Alternative 2 at this waste site is not justifiable because no risk drivers are present at this site.	Readily implementable, including feasible monitoring approach.	$0
Waste Site Analogous to 216-S-10 Pond							
216-S-11 Pond	Meets this criterion. Implementation of Alternative 2 at this waste site is not justifiable because no risk drivers are present at this site.	The identified ARARs are not applicable to this site.	Meets this criterion. Implementation of Alternative 2 at this waste site is not justifiable because no risk drivers are present at this site.	Meets this criterion. Implementation of Alternative 2 at this waste site is not justifiable because no risk drivers are present at this site.	Meets this criterion. Implementation of Alternative 2 at this waste site is not justifiable because no risk drivers are present at this site.	Readily implementable, including feasible monitoring approach.	$0

ARAR = applicable or relevant and appropriate requirement.
COC = contaminant of concern.
DOE = U.S. Department of Energy.
RAO = remedial-action alternative.

Table 7-4. Detailed Analysis Summary for Alternative 3 – Removal, Treatment, and Disposal. (2 Pages)

Waste Site	Threshold Criteria		Balancing Criteria				
	Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Present Worth Cost in Thousands**
Representative Waste Sites							
216-A-29 Ditch	Protective. Excavation would remove 2.6 m (8.5 ft) of contaminants for Segment 1 and 2.0 m (6.5 ft) of contaminants for Segment 3. Would eliminate direct contact with human and ecological receptors.	Complies.	Meets this criterion because both long-term engineered soil removal with institutional controls and monitoring are provided.	Meets this criterion because mobility of the contaminants is reduced when the waste site is excavated.	Meets this criterion because both community and workers are protected during remedial actions with no adverse environmental impacts, and remedial response objectives will be achieved in a reasonable time frame.	Readily implementable, including feasible monitoring approach, adequate on-site disposal capacity, and available equipment and personnel.	$2,362
216-B-63 Trench	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	$0

Table 7-4. Detailed Analysis Summary for Alternative 3 – Removal, Treatment, and Disposal. (2 Pages)

Waste Site	Threshold Criteria		Balancing Criteria				
	Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Present Worth Cost in Thousands**
216-S-10 Ditch	Protective. The uncovered Segment 2 would be excavated to 4.6 m (15 ft) bgs. Would eliminate direct contact with ecological receptors.	Complies.	Meets this criterion because both long-term engineered soil removal with institutional controls and monitoring are provided.	Meets this criterion because mobility of the contaminants is reduced when the waste site is excavated.	Meets this criterion because both community and workers are protected during remedial actions with no adverse environmental impacts, and remedial response objectives will be achieved in a reasonable time frame.	Readily implementable, including feasible monitoring approach, adequate on-site disposal capacity, and available equipment and personnel.	$2,319
216-S-10 Pond	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	$0
Waste Site Analogous to 216-S-10 Pond							
216-S-11 Pond	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 3 is not justifiable.	$0

ARAR = applicable or relevant and appropriate requirement.
COC = contaminant of concern.

Table 7-5. Detailed Analysis Summary for Alternative 4 – Engineered Barrier. (2 Pages)

Waste Site	Threshold Criteria: Overall Protection of Human Health and the Environment	Threshold Criteria: Compliance with ARARs	Balancing Criteria: Long-Term Effectiveness and Permanence	Balancing Criteria: Reduction of Toxicity, Mobility, or Volume Through Treatment	Balancing Criteria: Short-Term Effectiveness	Balancing Criteria: Implementability	Balancing Criteria: Present Worth Cost in Thousands
Representative Waste Sites							
216-A-29 Ditch	Protective. Controls potential exposure pathways to receptors through placement of an ET Monofill Barrier to limit infiltration and intrusion.	Complies.	Meets this criterion because long-term engineered monofill barriers plus institutional controls and monitoring are provided.	Meets this criterion when the barrier is placed to reduce mobility of contaminants by reducing infiltration into the waste site.	Meets this criterion because both community and workers are protected during remedial actions with no adverse environmental impacts, and remedial response objectives will be achieved in a reasonable time frame.	Readily implementable, including feasible monitoring approach and available equipment and personnel.	$4,339
216-B-63 Trench	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	$0
216-S-10 Ditch	Protective. Controls potential exposure pathways to receptors through placement of an ET Monofill Barrier to limit infiltration and intrusion.	Complies.	Meets this criterion because long-term engineered monofill barriers plus institutional controls and monitoring are provided.	Meets this criterion when the barrier is placed to reduce mobility of contaminants by reducing infiltration into the waste site.	Meets this criterion because both community and workers are protected during remedial actions with no adverse environmental impacts, and remedial response objectives will be achieved in a reasonable time frame.	Readily implementable, including feasible monitoring approach and available equipment and personnel.	$2,916

Table 7-5. Detailed Analysis Summary for Alternative 4 – Engineered Barrier. (2 Pages)

Waste Site	Threshold Criteria		Balancing Criteria				
	Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Present Worth Cost in Thousands**
216-S-10 Pond	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	$0
Waste Site Analogous to 216-S-10 Pond							
216-S-11 Pond	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	No risk drivers are present at this waste site; therefore, Alternative 4 is not justifiable.	$0

ARAR = applicable or relevant and appropriate requirement.
COC = contaminant of concern.
ET = Evapotranspiration.

8.0 COMPARATIVE ANALYSIS

The 200-CS-1 OU remedial action alternatives, which are developed in Chapter 6.0 and analyzed in detail in Chapter 7.0, are compared in this section. The comparative analysis identifies the relative advantages and disadvantages of each alternative, so the key issues are made transparent for the risk managers (the Tri-Parties). The comparative analysis provides a measure of the relative performance of the alternatives against each evaluation criterion.

The nine CERCLA evaluation criteria, as detailed in EPA/540/G-89/004, are as follows:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- State acceptance; and
- Community acceptance.

The first two criteria, overall protection of human health and the environment and compliance with ARARs, are threshold criteria. For the threshold criteria, the remedial action alternatives are compared relative to each other in Section 8.1. The next five criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost) are balancing criteria. Section 8.2 discusses the remedial alternative comparisons relative to each of the balancing evaluation criteria.

The final two criteria, State and community acceptance, are modifying criteria. The criterion of State acceptance will be addressed in the upcoming Proposed Plan, prepared by the Tri-Parties. The Proposed Plan will identify the preferred remedy (or remedies) accepted by the Tri-Parties. The criterion of community acceptance will be evaluated following the issuance of the Proposed Plan for public review and comment.

Section 8.1 addresses the threshold criteria and Section 8.2 addresses the balancing criteria. Tables 8-1, 8-2, 8-3, 8-4, and 8-5 summarize how each waste soil remedial action alternative satisfies the RAOs identified in Chapter 4.0 for 216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, 216-S-10 Pond, and 216-S-11 Pond, respectively. Tables 8-6, 8-7, 8-8, 8-9, and 8-10 summarize the relative performance of each 200-CS-1 OU alternative by evaluation criterion for the 216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, 216-S-10 Pond, and 216-S-11 Pond, respectively.

8.1 THRESHOLD CRITERIA

Threshold criteria are of greatest importance in the comparative analysis, because they reflect the key statutory mandates of CERCLA, as amended. The threshold criteria that any viable alternative must meet are as follows:

- Overall protection of human health and the environment

- Compliance with ARARs and other information to be considered.

200-CS-1 OU remedial alternatives are compared with respect to the threshold criteria below.

8.1.1 Overall Protection of Human Health and the Environment

The primary measure of this criterion is the ability of an alternative to attain RAOs for the 200-CS-1 OU waste sites and to protect groundwater. Alternatives are compared in Tables 8-1, 8-2, 8-3, 8-4, and 8-5 for the 216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, 216-S-10 Pond, and 216-S-11 Pond, respectively, regarding attainment of RAOs. The sites are discussed in detail below.

8.1.1.1 216-A-29 Ditch and 216-S-10 Ditch

Risk analysis of the 216-A-29 Ditch and the 216-S-10 Ditch showed that ecological and groundwater-protection pathway COCs and COECs are present at these waste sites (see Table 3-14). Alternatives 1 and 2 would not provide overall protection of the environment at these sites because contaminants would remain in place with no measures taken to reduce the volume and/or toxicity of the contaminants, control the exposure pathways to ecological receptors, or prevent migration of contaminants to groundwater. Therefore, Alternatives 1 and 2 would not achieve RAOs 1[1], 2[2], and 3[3] for the 216-A-29 Ditch. Alternatives 1 and 2 also would not achieve RAOs 1 and 3 for the 216-S-10 Ditch. RAO 2 is not applicable to the 216-S-10 Ditch waste site because radiological contaminants are not present at this site.

In comparison, Alternatives 3 and 4 would provide overall protection of the environment at the 216-A-29 Ditch and the 216-S-10 Ditch. Under Alternative 3, contaminated materials would be excavated to the depth required to reduce COCs and COECs below levels protective of the environment. The excavated materials would be removed from the waste site and disposed of at an approved waste disposal facility. Alternative 4 includes leaving the waste materials in place and installing an engineered barrier to control exposure pathways to ecological receptors and to prevent migration of contaminants to groundwater. Therefore, Alternatives 3 and 4 would achieve RAOs 1, 2, and 3 for the 216-A-29 Ditch and RAOs 1 and 3 for the 216-S-10 Ditch. As stated above, RAO 2 is not applicable to the 216-S-10 Ditch waste site because radiological contaminants are not present at this site.

8.1.1.2 216-B-63 Trench

COCs and COECs present at the 216-B-63 Trench do not justify a remedial action at this site. However, additional RESRAD analysis was performed for the 216-B-63 Trench using the same input parameters used for the BRA, except the soil cover was removed and was not included in the model, to evaluate the risk to industrial workers from radiological

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[1] RAO 1 – Prevent unacceptable risk to ecological receptors from exposure to soils and/or debris contaminated with nonradiological constituents at concentrations above the industrial use criteria.

[2] RAO 2 – Prevent unacceptable risk to ecological receptors or unacceptable dose to industrial workers from exposure to soils and/or debris contaminated with radiological constituents.

[3] RAO 3 – Prevent migration of nonradiological hazardous chemicals through the soil column to groundwater.

contaminants present at this site. Based on the results of the additional RESRAD analysis, a dose and risk was present for industrial workers at the 216-B-63 Trench; therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained for at least 150 years to protect industrial workers. See Appendix E for further details on the additional RESRAD analysis for the 216-B-63 Trench.

Alternative 1 would not provide long-term maintenance of the existing soil cover at the 216-B-63 Trench; therefore, it would not achieve RAO 2 for this site. In comparison, Alternative 2 would provide long-term maintenance of the existing soil cover at the 216-B-63 Trench. Therefore, Alternative 2 would achieve RAO 2 for the 216-B-63 Trench. RAO 1 is not applicable to this site because nonradiological COECs are not present at this waste site. RAO 3 is not applicable to this waste site because radiological groundwater COCs are not present at the 216-B-63 Trench. Alternatives 3 and 4 would not occur at this site because COCs and COECs are not present at levels that would justify a removal or capping action.

8.1.1.3 216-S-10 Pond and 216-S-11 Pond

COCs and COECs present at the 216-S-10 Pond and its analogous site (216-S-11 Pond) do not justify remedial actions at these waste sites. Additional RESRAD modeling was performed for the 216-S-10 and 216-S-11 Ponds using the same input parameters used for the BRA, except the soil cover was removed and was not included in the model, to evaluate the risk to industrial workers from radiological contaminants present at these sites. The RESRAD modeling for the 216-S-10 Pond and its analogous site (216-S-11 Pond) demonstrated that the soil cover is not needed to protect industrial workers from radiological contaminants present at these sites. Therefore, Alternative 1 for the 216-S-10 and 216-S-11 Ponds would provide overall protection of human health and the environment.

Alternatives 2, 3, and 4 are not justifiable at the 216-S-10 and 216-S-11 Ponds because COCs and COECs are not present at levels that would justify the need for maintenance of the existing soil cover, removal or containment of contaminated soils.

8.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

ARARs are any appropriate standards, criteria, or limitations under any federal environmental law or more stringent State requirement that must be either met or waived for any hazardous substance, pollutant, or contaminant that will remain on site during or after completion of a remedial action. ARARs for each alternative were discussed in Chapter 7.0 and a comprehensive list of ARARs is provided in Appendix G.

Chemical-specific ARARs identified for Alternatives 1 through 4 include those related to national primary drinking water regulations under 40 CFR 141, PCB remediation waste storage and disposal under 40 CFR 761, and soil cleanup standards for industrial properties under WAC 173-340-745(5)(b). Action-specific ARARs identified for the four alternatives include those related to closure/post-closure of dangerous waste sites and dangerous waste landfills under WAC 173-303-610 and WAC 173-303-665, respectively. These ARARs are not applicable to the sites where no risk drivers are present, which include the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

In addition to the chemical- and action-specific ARARs, some location-specific ARARs were identified as being applicable to Alternatives 3 and 4 because these alternatives involve ground disturbance as part of the remediation activities. These ARARs include regulations related to preservation of historical and archaeological sites (*Archeological and Historic Preservation Act of 1960* and *National Historic Preservation Act of 1966*) and endangered and threatened species (*Endangered Species Act of 1973*).

Alternative 1 involves a no-action approach, which means contaminants will remain in place with no measures taken to reduce the volume and/or toxicity of the contaminants, control the exposure pathways to ecological receptors, or prevent migration of contaminants to groundwater. Alternative 2 involves maintaining existing soil covers and allowing contaminants beneath the soil covers to naturally attenuate until remediation goals are met. A minimum soil cover of 4.6 m (15 ft) is required to provide a sufficient barrier to protect human health and the environment. Existing soil covers at the 216-A-29 Ditch and the 216-S-10 Ditch are only a few feet thick and do not meet the thickness requirement. In addition, some of the contaminants, such as heavy metals, present at the waste sites would require a long period to naturally attenuate and a sufficient barrier would not be installed to protect the environment during that time. Therefore, Alternatives 1 and 2 would not minimize or eliminate contaminants to the extent necessary to protect the environment. This means that ecological and groundwater protection criteria would not be achieved, and no action would be taken to control exposure pathways to the contaminants. Therefore, these alternatives would not meet the ARARs identified for the 216-A-29 Ditch and the 216-S-10 Ditch.

Alternative 3 involves excavating and removing contaminated soils from the waste sites and disposing of the excavated materials at an approved disposal facility. By removing the contaminated materials from the waste sites and using uncontaminated soils to backfill the excavations, contaminants would be minimized and/or eliminated to the extent necessary to protect the environment. This means that ecological and groundwater protection criteria would be achieved and exposure pathways to contaminants would be controlled. Therefore, this alternative would meet the ARARs identified for the 216-A-29 Ditch and the 216-S-10 Ditch.

Alternative 4 involves leaving the contaminated waste in place and constructing an engineered surface barrier over the waste to provide protection of the environment. Alternative 4 would comply with all ARARs for the 216-A-29 Ditch and the 216-S-10 Ditch by breaking the pathways for exposure and emplacing caps that meet the substantive requirements of the regulations. In addition to the cap, this alternative includes IC elements such as land-use restrictions and groundwater monitoring.

For Alternatives 3 and 4, it is anticipated that the appropriate agencies would be contacted and the appropriate archaeological and ecological surveys would be completed prior to any land disturbance or excavation activities. Therefore, these alternatives would be in compliance with the location-specific ARARs identified for the 216-A-29 Ditch and the 216-S-10 Ditch.

8.2 BALANCING CRITERIA

200-CS-1 OU alternatives are compared with respect to the balancing criteria in the following discussion. The primary balancing criteria to which relative advantages and disadvantages of the alternatives are compared include the following:

1. Long-term effectiveness and permanence
2. Reduction of toxicity, mobility, and volume through treatment
3. Short-term effectiveness
4. Implementability
5. Cost.

The first balancing criterion assesses the ability of the alternative to remain effective for the duration of risk. The second balancing criterion addresses the statutory preference for treatment as a principal element of the remedy and the bias against off-Site land disposal of untreated material. Together with the third and fourth criteria, they form the basis for determining the general feasibility of each potential remedy. The final criterion addresses whether the costs associated with a potential remedy are proportional to its overall effectiveness, considering both the cleanup period and operation and maintenance requirements during and following cleanup. Therefore, it can be determined whether a potential remedy is cost effective relative to other potential remedies. Key tradeoffs among alternatives will most frequently relate to one or more of the balancing criteria. Alternatives are compared in Tables 8-6, 8-7, 8-8, 8-9, and 8-10 for the 216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, 216-S-10 Pond, and 216-S-11 Pond, respectively, regarding the balancing criteria and the sites are discussed below.

8.2.1 Long-Term Effectiveness and Permanence

There are no risk drivers present at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds. The additional RESRAD modeling for the 216-S-10 Pond and its analogous site (216-S-11 Pond) demonstrated that long term maintenance of the soil cover is not needed to protect industrial workers from radiological contaminants present at these sites. Therefore, Alternative 1 for the 216-S-10 and 216-S-11 Ponds would provide long-term effectiveness and permanence. Additional RESRAD analysis performed for the 216-B-63 Trench showed that a dose and risk was present for industrial workers assuming no cover was present at the 216-B-63 Trench; therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained for at least 150 years to protect industrial workers. For the 216-B-63 Trench, 216-A-29 Ditch and the 216-S-10 Ditch, Alternative 1 would provide no long-term effectiveness or permanence, because the existing cover would not be maintained for the 216-B-63 Trench and no physical controls would be implemented to reduce the remaining risk to acceptable levels at the 216-A-29 Ditch and the 216-S-10 Ditch.

Because Alternative 2 would maintain the existing soil cover it would provide long-term effectiveness and permanence at the 216-B-63 Trench. However, at the 216-A-29 Ditch and the 216-S-10 Ditch, Alternative 2 would provide no long-term effectiveness or permanence, because no physical controls would be implemented to reduce the remaining risk to acceptable levels.

Alternative 3 would provide long-term effectiveness and permanence for contaminated soil by removing the soil from the 216-A-29 and 216-S-10 waste sites and disposing of this soil in the ERDF, an engineered containment facility. Alternative 4, capping with a monofill soil barrier, would provide long-term effectiveness and permanence by providing an engineered barrier over the 216-A-29 Ditch and the 216-S-10 Ditch waste sites. Alternatives 3 and 4 would include adequate and reliable institutional controls and monitoring to evaluate any exposure to potential receptors. Alternatives 3 and 4 would not occur at the 216-B-63 Trench or the 216-S-10 and 216-S-11 Ponds because there are no risk drivers present at these sites.

8.2.2 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternatives 1 and 2 would not reduce toxicity, mobility, or volume for any of the COCs/COECs considered risk drivers except through natural radioactive decay because treatment would not be implemented. There are no risk drivers present at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds. Therefore, Alternative 1 meets this criterion under CERCLA for these waste sites where there are no risk drivers present.

Alternatives 3 and 4 would not occur at the 216-B-63 Trench or the 216-S-10 and 216-S-11 Ponds because there are no risk drivers present at these sites and a removal or capping action is not justified. Alternative 3 would reduce the mobility of the COCs/COECs considered risk drivers at the 216-A-29 Ditch and the 216-S-10 Ditch when the waste sites are excavated and the contaminated soil is disposed of in the ERDF. Also, Alternative 3 would reduce the volume of contaminated soil at the 216-A-29 Ditch and the 216-S-10 Ditch. Alternative 4, capping with a monofill soil barrier, would reduce the mobility of the COCs/COECs considered risk drivers by reducing the infiltration into the 216-A-29 Ditch and the 216-S-10 Ditch waste sites, and would provide the most long-term effectiveness and permanence by providing an engineered barrier over these waste sites.

8.2.3 Short-Term Effectiveness

For Alternatives 1 and 2, RAOs can only be fully met through natural attenuation of contaminants, which can take hundreds of years to achieve and will not meet RAOs in a short-term time frame. Because there are no risk drivers present at the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds, Alternatives 1 and 2 would meet the short-term effectiveness criterion for these waste sites. For the 216-A-29 Ditch and the 216-S-10 Ditch, Alternatives 1 and 2 would not be an effective short-term alternative because the amount of time is very large until the remedial action objectives would be met through natural attenuation at these sites.

Alternatives 3 and 4 would not occur at the 216-B-63 Trench or the 216-S-10 and 216-S-11 Ponds because risk drivers are not present at these sites and a removal or capping action is not justified. Alternatives 3 and 4 at the 216-A-29 Ditch and the 216-S-10 Ditch would protect both the community and remediation workers, would not create any adverse environmental impacts, and the RAOs would be met in a reasonably short time frame (months).

8.2.4 Implementability

For all of the 200-CS-1 OU waste sites, all the alternatives are readily implementable. However, Alternatives 3 and 4 would not occur at the 216-B-63 Trench or the 216-S-10 and 216-S-11 Ponds because risk drivers are not present at these sites and a removal or capping action is not justified. Alternative 2 would include a feasible monitoring approach. Alternative 3 would utilize adequate on-site disposal capacity at the ERDF and would be readily implemented from available equipment and personnel plus utilize a feasible monitoring approach. Alternative 4 would be readily implemented from available equipment and personnel plus utilize a feasible monitoring approach.

8.2.5 Cost

8.2.5.1 216-A-29 Ditch

The present worth costs for the four alternatives range from $0 for Alternative 1 to $4,339,088 for Alternative 4. The costs for all of the alternatives are provided in Table 8-6.

8.2.5.2 216-B-63 Trench

The present worth costs for Alternatives 1 and 2 at the 216-B-63 Trench range from $0 for Alternative 1 to $1,064,146 for Alternative 2. Alternatives 3 and 4 would not occur at the 216-B-63 Trench because risk drivers are not present at this site and a removal or capping action is not justified. Therefore, there is no cost for these alternatives at the 216-B-63 Trench. The costs for all of the alternatives are provided in Table 8-7.

8.2.5.3 216-S-10 Ditch

The present worth costs for the four alternatives range from $0 for Alternative 1 to $2,916,031 for Alternative 4. The costs for all of the alternatives are provided in Table 8-8.

8.2.5.4 216-S-10 Pond

The present worth cost for Alternative 1 at the 216-S-10 Pond is $0. Alternatives 2, 3 and 4 would not occur at the 216-S-10 Pond because risk drivers are not present at this site and maintenance of the existing soil cover or a removal or capping action is not justified. Therefore, there is no cost for these alternatives at the 216-S-10 Pond. The costs for all of the alternatives are provided in Table 8-9.

8.2.5.5 216-S-11 Pond

The present worth cost for Alternative 1 at the 216-S-11 Pond is $0. Alternatives 2, 3 and 4 would not occur at the 216-S-11 Pond because risk drivers are not present at this site and maintenance of the existing soil cover or a removal or capping action is not justified. Therefore, there is no cost for these alternatives at the 216-S-11 Pond. The costs for all of the alternatives are provided in Table 8-10.

8.3 SUMMARY

Each of the five waste sites in the 200-CS-1 OU was analyzed for the four remedial action alternatives.

8.3.1 Threshold Criteria

Overall protection of human health and the environment and compliance with ARARs will generally serve as the threshold determinations in that they must be met by any alternative in order for it to be eligible for selection. Alternatives 3 and 4 meet the threshold determinations for the 216-A-29 Ditch and the 216-S-10 Ditch, while Alternatives 1 and 2 do not. Alternative 3, the combination of excavation and disposal of the contaminated soil in the

ERDF, is protective of the environment by removing all of the COCs and COECs at these waste sites by excavating to the greatest depth where the environmental risk drivers are currently located. Alternative 4, the installation of an engineered barrier, is also protective of the environment by placing a low-permeability monofill barrier to effectively control infiltration to protect groundwater and provide a barrier to prevent biotic intrusion and transport of contaminants to the surface. The two other alternatives (Alternatives 1 and 2) would not significantly improve overall protection of the environment at the 216-A-29 Ditch and the 216-S-10 Ditch because the risk drivers would remain in place subject to existing infiltration and no additional protection to ecological receptors would be provided.

For the 216-B-63 Trench, Alternative 2 meets the threshold criteria of overall protection of human health and the environment, while Alternative 1 does not. Based on results of additional RESRAD analysis at the 216-B-63 Trench, a dose and risk was identified for industrial workers; therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained. Alternative 2 would provide long term maintenance of the existing soil cover at the 216-B-63 Trench, which would provide protection to industrial workers from exposure to radiological contaminants at the site. Alternatives 3 and 4 would not occur at the 216-B-63 Trench because risk drivers are not present at this site and a removal or capping action is not justified.

Alternative 1 meets the threshold criteria of overall protection of human health and the environment for the 216-S-10 and 216-S-10 Ponds. This is because there are no risk drivers present at these waste sites. Alternatives 2, 3 and 4 would not occur at the 216-S-10 and 216-S-11 Ponds because risk drivers are not present at these waste sites and maintenance of the existing soil cover or a removal or capping action is not justified.

Alternatives 1 and 2 would also not meet the ARARs identified for 216-A-29 Ditch and the 216-S-10 Ditch. Specific ARARs not met are the chemical-specific ARARs identified for these alternatives including those related to national primary drinking water regulations under 40 CFR 141, PCB remediation waste storage and disposal under 40 CFR 761, and soil cleanup standards for industrial properties under WAC 173-340-745(5)(b). Also, action-specific ARARs would not be met for these alternatives including those related to closure/post-closure of dangerous waste sites and dangerous waste landfills under WAC 173-303-610 and WAC 173-303-665, respectively. Alternatives 3 and 4 would minimize or eliminate contaminants to the extent necessary to protect the environment. This means that ecological and groundwater protection criteria would be achieved, and effective remedial action would be taken to control exposure pathways to the contaminants. Therefore, Alternatives 3 and 4 would meet the ARARs identified for the 216-A-29 Ditch and the 216-S-10 Ditch. The ARARs are not applicable to the sites where risk drivers not present, which include the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

8.3.2 Balancing Criteria

Overall protection of human health and the environment and compliance with ARARs will generally serve as the threshold determinations in that they must be met by any alternative in order for it to be eligible for selection. Alternatives 3 and 4 meet the threshold determinations, while Alternatives 1 and 2 do not for the 216-A-29 Ditch and the 216-S-10 Ditch. Therefore, for the 216-A-29 Ditch and the 216-S-10 Ditch only

Alternatives 3 and 4 will be discussed further in this section regarding the five CERCLA criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost).

Alternatives 3 and 4 would not occur at the 216-B-63 Trench because risk drivers are not present at this site and a removal or capping action is not justified. Similarly, Alternatives 2, 3 and 4 would not occur at the 216-S-10 and 216-S-11 Ponds because risk drivers are not present at these sites and maintenance of the existing soil cover or a removal or capping action is not justified. Therefore, for the 216-B-63 Trench only Alternatives 1 and 2 will be discussed further, and for the 216-S-10 and 216-S-11 Ponds only Alternative 1 will be discussed further in this section regarding the five CERCLA criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost).

8.3.2.1 Long-Term Effectiveness and Permanence

216-A-29-Ditch and 216-S-10 Ditch

Alternative 3 does provide long-term engineered controls by excavating and disposing of contaminated soil to reduce exposures of ecological receptors to contaminated soil and downward migration of contaminants to groundwater. Five-year reviews may not be required because of the removal of the contamination. Removing the contaminated soil from the 216-A-29 Ditch and the 216-S-10 Ditch would provide a high degree of long-term effectiveness and permanence, because residual contamination would be removed for disposal in an engineered containment facility (i.e., ERDF). Alternative 4 would reduce risks to the environment to acceptable levels by breaking exposure pathways to ecological receptors from contaminated soil. Further, this alternative will reduce surface infiltration into the 216-A-29 Ditch and the 216-S-10 Ditch and subsequently reduce the downward migration of contaminants to groundwater. Chemicals and radionuclides left in place at the waste sites would be physically separated from receptors by the features and properties of the cap and by the additional thickness of the existing soil covers. Five-year reviews would be required because the contaminants are left in place underneath the monofill barrier. Alternative 3 is more effective than Alternative 4 because the contaminated soil is removed from the 200-CS-1 OU waste sites.

216-B-63 Trench

COCs and COECs identified at the 216-B-63 Trench do not justify remedial actions; however, the existing soil cover at this location may degrade over time. Based on additional RESRAD analysis performed for the 216-B-63 Trench assuming no soil cover was present, a dose and risk was present for industrial workers. Therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained for at least 150 years to protect industrial workers. Alternative 2 would provide long-term maintenance of the existing soil cover and would prove effective at protecting industrial workers from exposure to radiological contaminants.

216-S-10 and 216-S-11 Ponds

The RESRAD modeling for the 216-S-10 Pond and its analogous site (216-S-11 Pond) demonstrated that maintenance of the soil cover is not needed to protect industrial workers from radiological contaminants present at these sites. Therefore, Alternative 1 for the 216-S-10 and 216-S-11 Ponds would provide long-term effectiveness at these waste sites.

8.3.2.2 Reduction of Toxicity, Mobility, and Volume Through Treatment

216-A-29-Ditch and 216-S-10 Ditch

Alternative 3 does not provide any engineered treatment to reduce toxicity, mobility, or volume. This alternative provides a reduction in the mass of radionuclides and chemical contaminants at the 216-A-29 Ditch and the 216-S-10 Ditch. Treatment is not anticipated prior to disposal at the ERDF. Radiological decay at the ERDF ultimately results in reduction of toxicity and volume. Movement of the waste to the ERDF would result in reduction of mobility at both the waste sites and the ERDF over their current location. Reduction of toxicity, mobility, or volume would occur in the form of reduced infiltration through the 200-CS-1 OU waste sites and natural attenuation at these waste sites. The capping alternative reduces infiltration through the waste by storing precipitation that is used by the vegetative cover on top of the monofill barrier. By reducing infiltration at these sites, this alternative reduces the mobility of all the contaminants in the soil. Alternatives 3 and 4 are equally effective in reducing the toxicity, mobility, and volume because an engineered barrier is used at ERDF or at the 216-A-29 Ditch and the 216-S-10 Ditch waste sites to control mobility of contaminated soil.

216-B-63 Trench

Alternatives 1 and 2 do not provide any engineered treatment to reduce toxicity, mobility, or volume. Reduction of toxicity, mobility, or volume would only occur in the form of natural attenuation. Based on the risk analysis, there are no risk drivers present at the 216-B-63 Trench; therefore, Alternatives 1 and 2 are equally effective in reducing the toxicity, mobility, and volume at this waste site.

216-S-10 and 216-S-11 Ponds

Alternative 1 does not provide any engineered treatment to reduce toxicity, mobility, or volume. Reduction of toxicity, mobility, or volume would only occur in the form of natural attenuation. Based on the risk analysis, there are no risk drivers present at the 216-S-10 and 216-S-11 Ponds; therefore, Alternative 1 would be effective in reducing the toxicity, mobility, and volume at this waste site.

8.3.2.3 Short-Term Effectiveness

<u>Remediation Worker Risk</u>

216-A-29 Ditch and 216-S-10 Ditch

The levels of contamination at the 216-A-29 Ditch and the 216-S-10 Ditch waste sites are not expected to pose a risk to remediation workers when typical construction practices are followed from a Health and Safety Plan. For Alternative 3, typical practices should include enclosed excavation equipment and water-based dust suppression. These practices limit the remediation worker risk with minimal impact on schedule and cost because excavation with dust suppression and health and safety controls has been proven effective in excavating soil sites.

For Alternative 4, only minimal short-term remediation worker risks are expected, and these risks are associated with initial groundbreaking construction activities. As soon as the initial materials are placed over the 216-A-29 Ditch and the 216-S-10 Ditch, short-term worker risks decrease when typical construction practices are followed from a Health and Safety Plan.

Typical practices should include water-based dust suppression. These practices limit the remediation worker risk with minimal impact on schedule and cost because soil placement with dust suppression and health and safety controls has been proven effective in constructing barriers at similar soil contamination sites. Alternative 4 would not require excavation of contaminated soils, so the risks to remediation workers would be less than Alternative 3 because placement of the barrier reduces worker exposure to contaminants at the 216-A-29 Ditch and the 216-S-10 Ditch.

216-B-63 Trench

There would be no short-term risks to the public or industrial workers from the no-action alternative (Alternative 1) because remedial activities would not be conducted. For Alternative 2, only minimal short-term industrial worker risks are expected, and these risks are associated with monitoring and maintenance activities. Experienced workers using appropriate safety precautions would conduct these activities. Risks would decrease over time as the chemicals decompose. As such, the risk to industrial workers is qualitatively identified as low. Additionally, active DOE control of the Central Plateau is assumed for the next 50 years based upon future land-use planning. There would not be any short-term risks to the public due to existing DOE site access measures. Alternative 1 requires no remedial activities, so the risks to industrial workers would be less than Alternative 2 at the 216-B-63 Trench.

216-S-10 Pond and 216-S-11 Pond

There would be no short-term risks to the public or industrial workers from the no-action alternative (Alternative 1) because remedial activities would not be conducted at the 216-S-10 or 216-S-11 Ponds.

<u>Impact to Environment during Remediation</u>

216-A-29 Ditch and 216-S-10 Ditch

During completion of Alternative 3, physical disruption of the waste sites would increase human activity and noise. Potential animal intrusion and biological uptake are also issues that will require control of open excavations and exposed contaminated soils at the end of each day. This control could be accomplished through placement of covers or fixatives. Physical disruption of the waste sites during Alternative 4 would also result in increased human activity and noise. Alternative 3 has smaller areas of disturbed surface than Alternative 4. Transportation activities on the Central Plateau from Alternative 3 would increase as a result of bringing construction equipment to the site, transporting contaminated soils to the ERDF, and bringing clean fill to the excavated sites. Alternative 4 would have less environmental impact than Alternative 3 because the transportation of contaminated soil creates a greater environmental impact.

216-B-63 Trench

There would be no impact on the environment from the no-action alternative (Alternative 1) because risk drivers are not present at this site. Therefore, no remedial action would be conducted. Alternative 2 would not adversely impact the environment during construction and implementation because monitoring and maintenance activities are similar to existing ICs at these sites that are routinely implemented. The short-term impacts to the environment are expected to be low. Alternative 1 requires no remedial activities, so the impacts to the environment would be less than Alternative 2 at the 216-B-63 Trench.

216-S-10 Pond and 216-S-11 Pond

There would be no impact on the environment from the no-action alternative (Alternative 1) because risk drivers are not present at these waste sites. Therefore, no remedial action would be conducted at the 216-S-10 or 216-S-11 Ponds.

Time to Achieve the Remedial Action Objectives

216-A-29 Ditch and 216-S-10 Ditch

Alternatives 3 and 4 achieve the RAOs in the same amount of time.

216-B-63 Trench

For Alternative 1, remedy time is not necessary because no risk drivers are present at this waste site. Therefore, no remedial action would be conducted. Alternative 2 RAOs can only be fully met through natural decomposition of contaminants. This remedy time may require hundreds of years, depending on the COCs and their concentrations.

216-S-10 Pond and 216-S-11 Pond

For Alternative 1, remedy time is not necessary because no risk drivers are present at these waste sites. Therefore, no remedial action would be conducted.

8.3.2.4 Implementability

216-A-29 Ditch and 216-S-10 Ditch

Both alternatives are equally implementable at the 216-A-29 Ditch and the 216-S-10 Ditch.

216-B-63 Trench

Alternative 1 and 2 are equally implementable at the 216-B-63 Trench.

216-S-10 Pond and 216-S-11 Pond

Alternative 1 could be implemented immediately and would not present any technical problems. Radionuclides at the waste sites addressed by this FS are currently undergoing natural attenuation by radioactive decay. Other COCs and COECs are also undergoing natural attenuation where natural processes different than radioactive decay are involved.

8.3.2.5 Cost

216-A-29 Ditch and 216-S-10 Ditch

Alternative 3 has a lower cost than Alternative 4 for the 216-A-29 Ditch and the 216-S-10 Ditch.

216-B-63 Trench

Alternative 1 has a lower cost than Alternative 2 for the 216-B-63 Trench.

216-S-10 Pond and 216-S-11 Pond

No cost is associated with Alternative 1 at the 216-S-10 and 216-S-11 Ponds.

In summarizing the comparison of the balancing criteria, the substantive difference between Alternative 3 and 4 for the 216-A-29 Ditch and the 216-S-10 Ditch is cost by waste site. Regarding the four other criteria, there are only minor differences between these two alternatives.

In summarizing the comparison of the balancing criteria, the substantive difference between Alternatives 1 and 2 for the 216-B-63 Trench is cost. However, long-term maintenance of the existing soil cover is necessary to prevent exposure of industrial workers to unacceptable risk. Regarding the four other criteria, there are only minor differences between these two alternatives.

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Table 8-1. Comparison of 200-CS-1 Operable Unit Alternatives for the 216-A-29 Ditch with Respect to Remedial-Action Objectives.

Alternatives	RAO 1 [a]	RAO 2 [b]	RAO 3 [c]
Alternative 1—No Action	Will Not Achieve	Will Not Achieve	Will Not Achieve
Alternative 2—Maintain Existing Soil Cover and Monitored Natural Attenuation	Will Not Achieve	Will Not Achieve	Will Not Achieve
Alternative 3—Removal, Treatment, and Disposal	Will Achieve	Will Achieve	Will Achieve
Alternative 4—Engineered Barrier	Will Achieve	Will Achieve	Will Achieve

[a] Prevent unacceptable risk to ecological receptors from nonradiological contaminants.
[b] Prevent unacceptable risk to ecological receptors from radiological contaminants.
[c] Prevent migration of nonradiological contaminants through the soil column to groundwater.

RAO = remedial-action objective.

Table 8-2. Comparison of 200-CS-1 Operable Unit Alternatives for the 216-B-63 Trench with Respect to Remedial-Action Objectives

Alternatives	RAO 1 [a]	RAO 2 [b]	RAO 3 [c]
Alternative 1—No Action	N/A [d]	Will Not Achieve	N/A [d]
Alternative 2—Maintain Existing Soil Cover and Monitored Natural Attenuation	N/A [d]	Will Achieve	N/A [d]
Alternative 3—Removal, Treatment and Disposal	N/A [e]	N/A [e]	N/A [e]
Alternative 4—Engineered Barrier	N/A [e]	N/A [e]	N/A [e]

[a] Prevent unacceptable risk to ecological receptors from nonradiological contaminants.
[b] Prevent unacceptable risk to ecological receptors and unacceptable dose/risk to industrial workers from radiological contaminants.
[c] Prevent migration of nonradiological contaminants through the soil column to groundwater.
[d] Not applicable because there are no nonradiological contaminants of concern or radiological groundwater contaminants of concern present at this waste site.
[e] Not applicable because there are no risk drivers present at this waste site; therefore, a removal or capping action is not justified.

Table 8-3. Comparison of 200-CS-1 Operable Unit Alternatives for the 216-S-10 Ditch with Respect to Remedial-Action Objectives.

Alternatives	RAO 1 [a]	RAO 2 [b]	RAO 3 [c]
Alternative 1—No Action	Will Not Achieve	N/A [d]	Will Not Achieve
Alternative 2—Maintain Existing Soil Cover and Monitored Natural Attenuation	Will Not Achieve	N/A [d]	Will Not Achieve
Alternative 3—Removal, Treatment and Disposal	Will Achieve	N/A [d]	Will Achieve
Alternative 4—Engineered Barrier	Will Achieve	N/A [d]	Will Achieve

[a] Prevent unacceptable risk to ecological receptors from nonradiological contaminants.
[b] Prevent unacceptable risk to ecological receptors from radiological contaminants.
[c] Prevent migration of nonradiological contaminants through the soil column to groundwater.
[d] Not applicable because no radiological contaminants of concern are present at this waste site.

Table 8-4. Comparison of 200-CS-1 Operable Unit Alternatives for the 216-S-10 Pond with Respect to Remedial-Action Objectives.

Alternatives	RAO 1 [a]	RAO 2 [b]	RAO 3 [c]
Alternative 1—No Action	Will Achieve	Will Achieve	Will Achieve
Alternative 2—Maintain Existing Soil Cover and Monitored Natural Attenuation	NA [d]	NA [d]	NA [d]
Alternative 3—Removal, Treatment and Disposal	NA [d]	NA [d]	NA [d]
Alternative 4—Engineered Barrier	NA [d]	NA [d]	NA [d]

[a] Prevent unacceptable risk to ecological receptors from nonradiological contaminants.
[b] Prevent unacceptable risk to ecological receptors from radiological contaminants.
[c] Prevent migration of nonradiological contaminants through the soil column to groundwater.
[d] Not applicable to this waste site because risk drivers are not present and maintenance of the existing soil cover (Alternative 2), removal (Alternative 3), or containment (Alternative 4) of contaminated soils is not justified.

Table 8-5. Comparison of 200-CS-1 Operable Unit Alternatives for the 216-S-11 Pond with Respect to Remedial-Action Objectives.

Alternatives	RAO 1 [a]	RAO 2 [b]	RAO 3 [c]
Alternative 1—No Action	Will Achieve	Will Achieve	Will Achieve
Alternative 2—Maintain Existing Soil Cover and Monitored Natural Attenuation	NA [d]	NA [d]	NA [d]
Alternative 3—Removal, Treatment and Disposal	NA [d]	NA [d]	NA [d]
Alternative 4—Engineered Barrier	NA [d]	NA [d]	NA [d]

[a] Prevent unacceptable risk to ecological receptors from nonradiological contaminants.
[b] Prevent unacceptable risk to ecological receptors from radiological contaminants.
[c] Prevent migration of nonradiological contaminants through the soil column to groundwater.
[d] Not applicable to this waste site because risk drivers are not present and maintenance of the existing soil cover (Alternative 2), removal (Alternative 3), or containment (Alternative 4) of contaminated soils is not justified.

Table 8-6. Summary of Comparative Analysis for the 216-A-29 Ditch Alternatives. (3 Pages)

Threshold Criteria			Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Require-ments**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implemen-tability**	**Total Project Cost in Thousands (Net Present Worth in 2007 Dollars)**
Alternative 1—No Action	Not protective of the environment because contaminants are above risk-based protection criteria and remain in-place with no barrier.	Does not comply.	Fails to meet criteria because there is no change in risk and no controls are implemented.	Fails to meet criteria because there is no treatment or monitoring to demonstrate natural attenuation.	Fails to meet criteria because the time until RAOs are met is excessive.	Readily implement-able.	$0
Alternative 2—Maintain Existing Soil Cover and Monitored Natural Attenuation	Not protective of the environment because contaminants are above risk-based protection criteria and remain in-place with no barrier.	Does not comply.	Fails to meet criteria because there is no change in risk even though adequate controls are implemented.	Fails to meet criteria because reduction through natural attenuation takes too long to reduce toxicity effectively.	Fails to meet criteria because the time until RAOs are met is excessive.	Readily implement-able, including feasible monitoring approach.	$1,057

Table 8-6. Summary of Comparative Analysis for the 216-A-29 Ditch Alternatives. (3 Pages)

Threshold Criteria			Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Requirements**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Total Project Cost in Thousands (Net Present Worth in 2007 Dollars)**
Alternative 3—Removal, Treatment and Disposal	Protective. Excavation would remove 2.6 m (8.5 ft) of contaminants for Segment 1 and 2.0 m (6.5 ft) of contaminants for Segment 3. Would eliminate direct contact with ecological receptors.	Complies.	Meets this criterion because both long-term engineered soil removal with institutional controls and monitoring are provided.	Meets this criterion because mobility of the contaminants is reduced when the waste site is excavated.	Meets this criterion because both community and remediation workers are protected during remedial actions with no adverse environmental impacts and remedial response objectives will be achieved in a reasonable time frame.	Readily implement-able, including feasible monitoring approach, adequate on-site disposal capacity, and available equipment and personnel.	$2,362

Table 8-6. Summary of Comparative Analysis for the 216-A-29 Ditch Alternatives. (3 Pages)

Threshold Criteria			Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Require-ments**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implemen-tability**	**Total Project Cost in Thousands (Net Present Worth in 2007 Dollars)**
Alternative 4—Engineered Barrier	Protective. Controls potential exposure pathways to ecological receptors through placement of an ET Monofill Barrier to limit infiltration and intrusion.	Complies.	Meets this criterion because long-term engineered monofill barriers plus institutional controls and monitoring are provided.	Meets this criterion when the barrier is placed to reduce mobility of contaminants by reducing infiltration into the waste site.	Meets this criterion because both community and remediation workers are protected during remedial actions with no adverse environmental impacts, and remedial response objectives will be achieved in a reasonable time frame.	Readily implement-able, including feasible monitoring approach and available equipment and personnel.	$4,339

ARAR = applicable or relevant and appropriate requirement.
RAO = remedial-action objective.
TBC = to be considered.

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Table 8-7. Summary of Comparative Analysis for the 216-B-63 Trench Alternatives. (2 Pages)

	Threshold Criteria		Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Requirements**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implemen-tability**	**Total Project Cost in thousands (Net Present Worth in 2007 Dollars)**
Alternative 1—No Action	Fails to meet criteria because existing soil cover will degrade and, based on RESRAD modeling, assuming no soil cover exists, radiological contaminants would pose an unacceptable risk to industrial workers.	The identified ARARs are not applicable to this site.	Fails to meet criteria because existing soil cover will degrade and, based on RESRAD modeling, assuming no soil cover exists, radiological contaminants would pose an unacceptable risk to industrial workers.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Readily implement-able.	$0
Alternative 2—Maintain Existing Soil Cover and Monitored Natural Attenuation	Meets this criterion because Alternative 2 would provide long-term maintenance of the existing soil cover and would prevent exposure of industrial workers to unacceptable risk.	The identified ARARs are not applicable to this site.	Meets this criterion because Alternative 2 would provide long-term maintenance of the existing soil cover and would prevent exposure of industrial workers to unacceptable risk.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Readily implement-able, including feasible monitoring approach.	$1,064

Table 8-7. Summary of Comparative Analysis for the 216-B-63 Trench Alternatives. (2 Pages)

Threshold Criteria			Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Requirements**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implemen-tability**	**Total Project Cost in thousands (Net Present Worth in 2007 Dollars)**
Alternative 3—Removal, Treatment and Disposal	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	$0
Alternative 4—Engineered Barrier	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	$0

ARAR = applicable or relevant and appropriate requirement.
COC = contaminant of concern.
DOE = U.S. Department of Energy.
RESRAD = RESidual RADioactivity (dose model).
TBC = to be considered.

Table 8-8. Summary of Comparative Analysis for the 216-S-10 Ditch Alternatives. (2 Pages)

Threshold Criteria			Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Requirements**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implemen-tability**	**Total Project Cost in Thousands (Net Present Worth in 2007 Dollars)**
Alternative 1—No Action	Not protective of the environment because contaminants are above risk-based protection criteria and remain in-place with no barrier.	Does not comply.	Fails to meet criteria because there is no change in risk and no controls are implemented.	Fails to meet criteria because there is no treatment or monitoring to demonstrate natural attenuation.	Fails to meet criteria because the time until RAOs are met is excessive.	Readily implementable.	$0
Alternative 2—Maintain Existing Soil Cover and Monitored Natural Attenuation	Not protective of the environment because contaminants are above risk-based protection criteria and remain in-place with no barrier.	Does not comply.	Fails to meet criteria because there is no change in risk even though adequate controls are implemented.	Fails to meet criteria because reduction through natural attenuation taking too long to reduce toxicity effectively.	Fails to meet criteria because the time until RAOs are met is excessive.	Readily implementable, including feasible monitoring approach.	$1,066

Table 8-8. Summary of Comparative Analysis for the 216-S-10 Ditch Alternatives. (2 Pages)

Threshold Criteria			Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Requirements**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implemen-tability**	**Total Project Cost in Thousands (Net Present Worth in 2007 Dollars)**
Alternative 3—Removal, Treatment and Disposal	Protective. The uncovered Segment 2 would be excavated to 4.6 m (15 ft) bgs. Would eliminate direct contact with ecological receptors.	Complies.	Meets this criterion because both long-term engineered soil removal with institutional controls and monitoring are provided.	Meets this criterion because mobility of the contaminants is reduced when the waste site is excavated.	Meets this criterion because both community and remediation workers are protected during remedial actions with no adverse environmental impacts and remedial response objectives will be achieved in a reasonable time frame.	Readily implementable, including feasible monitoring approach, adequate on-site disposal capacity, and available equipment and personnel.	$2,319
Alternative 4—Engineered Barrier	Protective. Controls potential exposure pathways to ecological receptors through placement of an ET Monofill Barrier to limit infiltration and intrusion.	Complies.	Meets this criterion because both long-term engineered soil removal with institutional controls and monitoring are provided.	Meets this criterion because mobility of the contaminants is reduced when the waste site is excavated.	Meets this criterion because both community and remediation workers are protected during remedial actions with no adverse environmental impacts and remedial response objectives will be achieved in a reasonable time frame.	Readily implementable, including feasible monitoring approach, adequate on-site disposal capacity, and available equipment and personnel.	$2,916

ARAR = applicable or relevant and appropriate requirement.
RAO = remedial-action objective.
TBC = to be considered.

Table 8-9. Summary of Comparative Analysis for the 216-S-10 Pond Alternatives. (2 Pages)

Threshold Criteria			Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Requirements**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Total Project Cost in Thousands (Net Present Worth in 2007 Dollars)**
Alternative 1—No Action	Meets this criterion because no risk drivers are present at this site.	The identified ARARs are not applicable to this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Readily implementable.	$0
Alternative 2—Maintain Existing Soil Cover and Monitored Natural Attenuation	Meets this criterion because no risk drivers are present at this site.	The identified ARARs are not applicable to this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Readily implementable, including feasible monitoring approach.	$0
Alternative 3—Removal, Treatment and Disposal	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	$0

Table 8-9. Summary of Comparative Analysis for the 216-S-10 Pond Alternatives. (2 Pages)

Threshold Criteria			Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Require-ments**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implemen-tability**	**Total Project Cost in Thousands (Net Present Worth in 2007 Dollars)**
Alternative 4—Engineered Barrier	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	$0

ARAR = applicable or relevant and appropriate requirement.
COC = contaminant of concern.
TBC = to be considered.

Table 8-10. Summary of Comparative Analysis for the 216-S-11 Pond Alternatives. (2 Pages)

Threshold Criteria			Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Require-ments**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implemen-tability**	**Total Project Cost in Thousands (Net Present Worth in 2007 Dollars)**
Alternative 1—No Action	Meets this criterion because no risk drivers are present at this site.	The identified ARARs are not applicable to this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Readily implementable.	$0
Alternative 2—Maintain Existing Soil cover and Monitored Natural Attenuation	Meets this criterion because no risk drivers are present at this site.	The identified ARARs are not applicable to this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Meets this criterion because no risk drivers are present at this site.	Readily implementable, including feasible monitoring approach.	$0
Alternative 3—Removal, Treatment and Disposal	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 3 is not justifiable.	$0

Table 8-10. Summary of Comparative Analysis for the 216-S-11 Pond Alternatives. (2 Pages)

Threshold Criteria			Primary Balancing Criteria				
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARAR and TBC Require-ments**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implemen-tability**	**Total Project Cost in Thousands (Net Present Worth in 2007 Dollars)**
Alternative 4—Engineered Barrier	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	Risk drivers are not present at this site; therefore, Alternative 4 is not justifiable.	$0

ARAR = applicable or relevant and appropriate requirement.
COC = contaminant of concern.
TBC = to be considered.

9.0 SUMMARY AND CONCLUSIONS

This chapter summarizes the results of the revised BRA and the FS that identified and evaluated the alternatives for remediation at the 200-CS-1 OU. This document contains the following information.

- Chapter 2.0 presents background information including an overview of the OU, operational histories, descriptions of the waste sites, physical setting, and natural resources, and summarizes the representative and analogous waste sites.
- Chapter 3.0 discusses the BRA completed for the RI and presents the revised BRA. Three risk assessments are completed following EPA and *Washington Administrative Code* guidance: human health, ecological, and groundwater protection pathway. The uncertainties associated with these risk assessments and the implications for the FS are discussed.
- Chapter 4.0 discusses land-use assumptions and develops the overall remedial action objectives and media-specific goals for the waste sites including volumes of contaminated media for each waste site in the 200-CS-1 OU.
- Chapter 5.0 refines the remedial actions identified for the 200 Area waste sites in the Implementation Plan (DOE/RL-98-28). Refining considerations include effectiveness (likelihood of meeting RAOs for the specific contaminants present at the site), implementability relative to specific site conditions, status of technology development, and relative cost. Remedial alternatives were considered with respect to the effectiveness, implementability, and relative cost.
- Chapter 6.0 describes the remedial-alternative development process, initially conducted as part of the Implementation Plan (DOE/RL-98-28) development, and uses that information in concert with the risk assessment results to develop the remedial alternatives to be carried forward for detailed and comparative analyses.
- Chapter 7.0 presents a detailed analysis of each of the four remedial alternatives against seven of the nine CERCLA evaluation criteria defined in EPA/540/G-89/004. Of these nine CERCLA evaluation criteria, seven are alternative bounding criteria (protection of human health and the environment; regulatory compliance; long-term effectiveness; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost) and two deal with the public comment process. These two criteria will not be used in this FS. This section also assesses each alternative relative to the *National Environmental Policy Act of 1969* (NEPA) values, as required by DOE.
- Chapter 8.0 presents a comparative analysis of the four remedial alternatives and identifies their relative advantages and disadvantages, based on the seven alternative bounding CERCLA evaluation criteria. The results of this analysis provide a basis for

selecting a remedial alternative for each representative waste site and its analogous waste sites.

9.1 BASELINE RISK ASSESSMENT SUMMARY

In developing the FS, it was recognized that the qualitative nature of the original sampling strategy results in biases and uncertainties associated with the degree and extent of contamination. This, in turn, causes uncertainty in the level of risk and areas and volumes of waste addressed in the FS. As a result, understanding the original site-characterization strategy and the implications of the uncertainty analysis is important to alternative evaluation and devising post-ROD strategies to achieve a safe, effective, and efficient remedy.

The RI sampling strategy focused on potential groundwater impacts and was designed to support a qualitative risk assessment. The sampling was biased to identify worst case/maximum concentration conditions. The Work Plan anticipated additional sampling in the remedial-design/remedial-action phase to better identify the extent of contamination. At the same time the FS was being drafted, the Tri-Parties conducted a supplemental DQO process for waste sites on the Central Plateau that resulted in Tri-Party Agreement Change Package M-15-06-02 and the supplemental Work Plan for OUs (DOE/RL-2007-02). This process and the resulting Tri-Party documents did not identify supplementary RI sampling for the waste sites in the 200-CS-1 OU. Considering these factors, DOE decided to review and regenerate the analytical data, collected previously during the RI and other surveys, into the latest tabular format. These data support the revised BRA, which reflects the inherent uncertainties and provides the basis for the FS.

The revised BRA follows WAC and EPA guidance and was conducted for each of the four representative waste sites. The four representative waste sites for the 200-CS-1 OU are the 216-A-29 Ditch, the 216-B-63 Trench, the 216-S-10 Ditch, and the 216-S-10 Pond. The 216-S-11 Pond is an analogous waste site to the 216-S-10 Pond.

A human-health risk assessment, SLERA, and the groundwater-protection pathway evaluation were completed under the industrial land-use scenario for each waste site. The exposure-unit evaluated is the dimension of each waste site. Radiological and nonradiological constituents in shallow-zone soils (i.e., 0 to 4.6 m [0 to 15 ft] bgs) are evaluated for potential human-health and ecological impacts. An evaluation of potential groundwater impacts related to soil contamination is conducted for contaminants from the surface to the water table (i.e., 0 to approximately 76 m [250 ft] bgs).

9.1.1 Human-Health Risk

Minimal human-health risks were identified for the four sites under the industrial land-use scenario (less than the 10^{-5} carcinogenic-risk criterion or hazard quotients less than one). Nonradionuclide contaminants were eliminated in either the data-evaluation or the risk assessment phase. Radionuclide health risks calculated under this scenario were found to be less than the 10^{-5} carcinogenic risk criterion. Generally, because of the assumption that the sites are covered with clean backfill, no risk or toxicity criteria are exceeded. As a result, no inhalation and ingestion are predicted to occur, and the external dose to radionuclides is small because of shielding by the soil cover. The sampling strategy and risk assessment methodologies employed were intended to bias the result to overestimate risk and are likely to indicate that chemicals are a health risk. This baseline assessment is dependant on the assumption that the existing clean cover at these waste sites remains intact in perpetuity. Because the DOE plans to maintain control of the Hanford Site into the foreseeable future, this assumption likely does not underestimate risk.

9.1.2 Ecological Risk

The SLERA found a number of constituents, including both nonradionuclides and radionuclides that may pose a potential threat to ecological receptors. Comparisons of maximum observed concentrations to the industrial land-use criteria (WAC 173-340-7493) and other EPA and DOE criteria show unacceptable ecological risks from exposure to contaminated soils and/or debris. Cesium-137 at the 216-A-29 Ditch, and Cs-137 and Sr-90 at the 216-B-63 Trench were the only radionuclides greater than DOE target criteria for ecological receptors. Overall, the SLERA performed for the 200-CS-1 OU waste sites was a conservative evaluation process designed to avoid underestimating potential risks to wildlife.

9.1.3 Groundwater-Protection Pathway

A groundwater-protection pathway evaluation was completed to identify if soil contamination in the vadose zone potentially impacts groundwater below the waste sites. The revised evaluation found that a number of constituents at all of the 200-CS-1 OU waste sites posed a threat to groundwater, based on *Washington Administrative Code* CULs. RESRAD was used to model groundwater concentrations, and a couple of radionuclides were estimated to be greater than maximum contaminant levels within 1,000 and 10,000 years. The COCs likely overestimate risk, but it is unlikely that further fate and transport modeling would better inform the FS evaluation or risk-management decisions.

9.1.4 Implications to the Feasibility Study

The results of the three risk assessments described above are shown in Tables 3-13a through 3-13d. However, those COCs and COECs were further evaluated to determine risk drivers and implications for the FS, as described in Section 3.7. Table 3-14 summarizes the COCs/COECs considered risk drivers that form the basis for the evaluations completed as part of the FS. The inherent bias and uncertainty associated with the risk assessment are described in Sections 3.4.3, 3.5.4, 3.6.3, and 3.7.2 and are important factors in understanding the outcome of the BRA.

Uncertainty in risk determinations generally reflects limitations in knowledge resulting from the quality of the available database and the simplifying assumptions made to quantify risks.

Under- or overestimation of risk can lead, respectively, to failure to remediate true hazards, or unnecessary cleanup and expense. The bias associated with the sampling strategy and the assumptions made in using these data are sources of uncertainty in these analyses.

Uncertainty in the development of media concentrations derives from the limited number of independent sample locations and the sampling strategy. The sampling strategy employed was designed to avoid underestimation of media concentrations by identifying the worst case/maximum locations, thus avoiding an underestimation of the risks. The use of the maximum concentrations to bias the assessment toward protectiveness substantially affects all three risk assessments. Assessment of potential risk at the evaluation level also typically applies conservative risk factors that tend to overestimate, rather than underestimate, risk. As a result, risks for areas where samples were collected are more likely overestimated (i.e., potential false-positive errors) and may have resulted in a remedy that is larger in scope than actually required. The extent of required remediation likely could be reduced, or potentially increased, through confirmatory sampling.

However, uncertainties exist in areas where no samples were collected. These areas (i.e., the surface materials above the topmost samples) were assumed to be clean and present no risk. As a result, only false-negative error is possible in these locations and, conversely, confirmatory sampling could identify additional remediation.

9.2 FEASIBILITY-STUDY SUMMARY

Four remediation alternatives were identified to address the ecological and groundwater-pathway risks:

- Alternative 1 – No Action
- Alternative 2 – Maintain Existing Soil Cover and Monitored Natural Attenuation
- Alternative 3 – Removal, Treatment, and Disposal
- Alternative 4 – Engineered Barrier.

Alternative 1 – No-Action. 40 CFR 300 requires that a no-action alternative be evaluated as a baseline for comparison with other remedial alternatives. The no-action alternative represents a situation where no legal restrictions, ICs, access controls, or active remedial measures are applied to the site.

Alternative 2 – Maintain Existing Soil Cover and Monitored Natural Attenuation. This alternative takes advantage of existing soil covers and the nature of the contaminants to provide protection of human health and the environment. For all of the waste sites in this OU except the uncovered portion of the 216-S-10 Ditch, an existing soil cover associated with the previous waste-stabilization activities is present. Under this alternative, these existing soil covers will be maintained to provide protection from intrusion by biological receptors.

Alternative 3 – Removal, Treatment, and Disposal. Under this alternative, contaminated soil would be removed (by conventional excavation equipment) and disposed of at an appropriate facility (ERDF).

Alternative 4 – Engineered Barrier. The engineered barrier alternative, also known as the capping alternative, consists of constructing surface barriers over contaminated waste sites to control the amount of water that infiltrates into contaminated media, to reduce or eliminate leaching of contamination to groundwater and receptors contacting contaminated media. The particular barrier for this alternative is the ET Monofill Barrier.

Comparison of Alternatives for all 200-CS-1 OU Waste Sites. Each of the five waste sites in the 200-CS-1 OU was analyzed for the four remedial-action alternatives. Alternatives 3 and 4 meet the threshold criteria of overall protection of human health and the environment and compliance with ARARs for the 216-A-29 Ditch and the 216-S-10 Ditch, while Alternatives 1 and 2 do not. Alternative 3, the combination of excavation and disposal of the contaminated soil in the ERDF, is protective of the environment by removing all of the COCs and COECs at these waste sites by excavating to the greatest depths where risk drivers are identified. Alternative 4, the installation of an engineered barrier, also is protective of the environment by placing a low-permeability monofill barrier that effectively controls infiltration to protect groundwater and provide a barrier to prevent biotic intrusion and transport of contaminants to the surface. Therefore, Alternatives 3 and 4 would meet the ARARs identified for the 216-A-29 Ditch and the 216-S-10 Ditch. The two other alternatives (Alternatives 1 and 2), would not significantly improve overall protection of the environment at the 216-A-29 Ditch and the 216-S-10 Ditch, because the COCs and COECs would remain in place subject to existing infiltration, and no additional protection to ecological receptors would be provided. Alternatives 1 and 2 also would not meet the ARARs identified for the 216-A-29 Ditch and the 216-S-10 Ditch.

Threshold Criteria (protection of human health and the environment; regulatory compliance)

For the 216-B-63 Trench, Alternative 2 meets the threshold criteria of overall protection of human health and the environment, while Alternative 1 does not. Based on results of additional RESRAD modeling at the 216-B-63 Trench, a dose risk was present for DOE site workers for the next 150 years; therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained. Alternative 2 would provide long-term maintenance of the existing soil cover at the 216-B-63 Trench, which would provide protection to DOE site workers from exposure to radiological contaminants at the site. Alternatives 3 and 4 would not occur at the 216-B-63 Trench, because no risk drivers were identified at this site. Alternative 1 meets the threshold criteria of overall protection of human health and the environment for the 216-S-10 and 216-S-11 Ponds. This is because no human health or environmental risks are posed by the contaminants present at these waste sites. Alternatives 2, 3, and 4 would not occur at the 216-S-10 and 216-S-11 Ponds, because no risk drivers were identified at this site. The ARARs are not applicable to the sites where there are no risk drivers present, which include the 216-B-63 Trench and the 216-S-10 and 216-S-11 Ponds.

Overall protection of human health and the environment and compliance with ARARs generally will serve as the threshold determinations, in that they must be met by any alternative for it to be eligible for selection. Alternatives 3 and 4 meet the threshold determinations, while Alternatives 1 and 2 do not for the 216-A-29 Ditch and the 216-S-10 Ditch. Therefore, for the 216-A-29 Ditch and the 216-S-10 Ditch, only Alternatives 3 and 4 will be discussed further in regard to the five CERCLA criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost).

In addition, Alternatives 3 and 4 would not occur at the 216-B-63 Trench, because no risk drivers were identified at this site. Similarly, Alternatives 2, 3 and 4 would not occur at the 216-S-10 and 216-S-11 Ponds, because risk drivers were not identified at this site. Therefore, for the 216-B-63 Trench, only Alternatives 1 and 2 will be discussed further, and for the 216-S-10 and 216-S-11 Ponds, only Alternative 1 will be discussed further regarding the five CERCLA criteria.

Balancing Criteria (long-term effectiveness)

Alternative 3 provides long-term engineered controls by excavating and disposing of contaminated soil to reduce exposures of ecological receptors to contaminated soil and downward migration of contaminants to groundwater. Five-year reviews may not be required because of the removal of the contamination. Removing the contaminated soil from the 216-A-29 Ditch and the 216-S-10 Ditch would provide a high degree of long-term effectiveness and permanence, because residual contamination would be removed for disposal in an engineered containment facility (i.e., ERDF). Alternative 4 would reduce risks to the environment to acceptable levels by breaking exposure pathways to ecological receptors from contaminated soil. Further, this alternative will reduce surface infiltration into the 216-A-29 Ditch and the 216-S-10 Ditch and subsequently will reduce the downward migration of contaminants to groundwater. Chemicals and radionuclides left in place at the waste sites would be physically separated from receptors by the features and properties of the cap and by the additional thickness of the existing soil covers. Five-year reviews would be required, because the contaminants are left in place underneath the monofill barrier. Alternative 3 is more effective than Alternative 4 because the contaminated soil is removed from the 200-CS-1 OU waste sites.

COCs and COECs identified at the 216-B-63 Trench do not justify remedial actions; however, the existing soil cover at this location may degrade over time. Based on additional RESRAD modeling performed for the 216-B-63 Trench, assuming no soil cover was present, a dose risk was present for DOE site workers for the next 150 years. Therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained for at least 150 years to protect DOE site workers. Alternative 2 would provide long-term maintenance of the existing soil cover and would prove effective at protecting DOE site workers from exposure to radiological contaminants. The RESRAD modeling for the 216-S-10 Pond and its analogous site (216-S-11 Pond) demonstrated that maintenance of the soil cover is not needed to protect DOE site workers from radiological contaminants present at these sites. Therefore, Alternative 1 for the 216-S-10 and 216-S-11 Ponds would provide long-term effectiveness at these waste sites.

Balancing Criteria (reduction of toxicity, mobility, or volume)

Alternative 3 does not provide any engineered treatment to reduce toxicity, mobility, or volume. This alternative provides a reduction in the mass of radionuclides and chemical contaminants at the 216-A-29 Ditch and the 216-S-10 Ditch. Treatment is not anticipated before the waste is disposed of at the ERDF. Radiological decay at the ERDF ultimately results in reduction of toxicity and volume. Movement of the waste to the ERDF would result in reduction of mobility at both the waste sites and the ERDF over their current location. Reduction of toxicity, mobility, or volume would occur in the form of reduced infiltration through the 200-CS-1 OU waste sites and natural attenuation at these waste sites. The capping alternative reduces infiltration through the waste by storing precipitation that is used by the vegetative cover on top of the monofill barrier. By reducing infiltration at these sites, this alternative reduces the mobility of all of the contaminants in the soil. Alternatives 3 and 4 are equally effective in reducing the toxicity, mobility, and volume, because an engineered barrier is used at the ERDF or at the 216-A-29 Ditch and the 216-S-10 Ditch waste sites to control mobility of contaminated soil.

Alternatives 1 and 2 do not provide any engineered treatment to reduce toxicity, mobility, or volume. Reduction of toxicity, mobility, or volume only would occur in the form of natural attenuation. Based on the risk analysis, no human-health or environmental risks are posed by the contaminants at the 216-B-63 Trench; therefore, Alternatives 1 and 2 are equally effective in reducing the toxicity, mobility, and volume at this waste site. Based on the risk analysis, no human-health or environmental risks are posed by the contaminants at the 216-S-10 and 216-S-11 Ponds; therefore, Alternative 1 would be effective in reducing the toxicity, mobility, and volume at this waste site.

The levels of contamination at the 216-A-29 Ditch and the 216-S-10 Ditch waste sites are not expected to pose a risk to workers when typical construction practices are followed from a health and safety plan. For Alternative 3, typical practices should include enclosed excavation equipment and water-based dust suppression. These practices limit the worker risk with minimal impact on schedule and cost, because excavation with dust suppression and health and safety controls has been proven effective in excavating soil sites.

Balancing Criteria (short-term effectiveness)

For Alternative 4, only minimal short-term worker risks are expected, and these risks are associated with initial groundbreaking construction activities. As soon as the initial materials are placed over the 216-A-29 Ditch and the 216-S-10 Ditch, short-term worker risks decrease when typical construction practices are followed from a health and safety plan. Typical practices should include water-based dust suppression. These practices limit the worker risk with minimal impact on schedule and cost, because soil placement with dust suppression and health and safety controls has been proven effective in constructing barriers at similar soil contamination sites. Alternative 4 would not require excavation of contaminated soils, so the risks to workers would be less than Alternative 3, because placement of the barrier reduces worker exposure to contaminants at the 216-A-29 Ditch and the 216-S-10 Ditch.

There would be no short-term risks to the public or workers from the no-action alternative (Alternative 1), because remedial activities would not be conducted. For Alternative 2, only minimal short-term worker risks are expected, and these risks are associated with monitoring and maintenance activities. Experienced workers using appropriate safety precautions would conduct these activities. Risks would decrease over time as the chemicals decompose. As such, the risk to workers is qualitatively identified as low. Additionally, active DOE control of the Central Plateau is assumed for the next 50 years, based on future land-use planning. There would not be any short-term risks to the public from existing DOE site-access measures. Alternative 1 requires no remedial activities, so the risks to workers would be less than Alternative 2 at the 216-B-63 Trench. There would be no risk to workers at the 216-S-10 or 216-S-11 Ponds, because under Alternative 1 remedial activities would not be conducted.

During completion of Alternative 3, physical disruption of the waste sites would increase human activity and noise. Potential animal intrusion and biological uptake also are issues that will require control of open excavations and of exposed contaminated soils at the end of each day. This control could be accomplished through placement of covers or fixatives. Physical disruption of the waste sites during Alternative 4 also would result in increased human activity and noise. Alternative 3 has smaller areas of disturbed surface than Alternative 4. Transportation activities on the Central Plateau from Alternative 3 would increase as a result of bringing construction equipment to the site, transporting contaminated soils to the ERDF, and bringing clean fill to the excavated sites. Alternative 4 would have less environmental impact than Alternative 3, because the transportation of contaminated soil creates a greater environmental impact.

There would be no impact on the environment from the no-action alternative (Alternative 1), because there are no risk drivers at this waste site. Therefore, no remedial action would be conducted. Alternative 2 would not adversely impact the environment during construction and implementation, because monitoring and maintenance activities are similar to existing ICs that are routinely implemented at these sites. The short-term impacts to the environment are expected to be low. Alternative 1 requires no remedial activities, so the impacts to the environment would be less than for Alternative 2 at the 216-B-63 Trench. There are no risk drivers present at the 216-S-10 and 216-S-11 Ponds; therefore, no remedial action would be conducted at these sites.

Alternatives 3 and 4 achieve the RAOs in the same amount of time for the 216-A-29 Ditch and the 216-S-10 Ditch. For the 216-B-63 Trench, the Alternative 1 remedy time is not necessary, because no risk drivers were identified. Under Alternative 2, RAOs only can be fully met through natural decomposition of contaminants. This remedy time for the 216-B-63 Trench may require hundreds of years, depending on COCs and their concentrations. For the 216-S-10 and 216-S-11 Ponds, Alternative 1 remedy time is not necessary, because no risk drivers were identified.

Balancing Criteria (implementability; cost)

Alternatives 3 and 4 are equally implementable at the 216-A-29 Ditch and the 216-S-10 Ditch. Alternative 3 has a lower cost than Alternative 4 for the 216-A-29 Ditch and the 216-S-10 Ditch. Alternatives 1 and 2 are equally implementable at the 216-B-63 Trench.

Alternative 1 has a lower cost than Alternative 2 for the 216-B-63 Trench. Alternative 1 could be implemented immediately at the 216-S-10 and 216-S-11 Ponds and would not present any technical problems. No cost is associated with Alternative 1 at the 216-S-10 and 216-S-11 Ponds.

In summarizing the comparison of the balancing criteria, the substantive difference between Alternatives 3 and 4 for the 216-A-29 Ditch and the 216-S-10 Ditch is cost by waste site. Regarding the four other criteria, there are only minor differences between these two alternatives. Likewise, the substantive difference between Alternatives 1 and 2 for the 216-B-63 Trench is cost. Regarding the four other criteria, there are only minor differences between these two alternatives.

9.3 CONCLUSIONS AND PATH FORWARD

The results of this FS form the basis for selecting a preferred alternative and for preparing the proposed plan for remediation at the five 200-CS-1 OU waste sites. Evaluation of ecological risk and the groundwater protection pathway identified contaminated soil to varying depths at these waste sites that are greater than both toxicity and water criteria. Table 9-1 summarizes the alternatives and the rationale for the suggested alternative for each site in the 200-CS-1 OU. Tables 9-2, 9-3, 9-4, 9-5, and 9-6 for the 216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, 216-S-10 Pond, and 216-S-11 Pond, respectively, summarize the evaluation of alternatives by site.

A proposed plan is being prepared to document the preferred alternatives for the 200-CS-1 OU (DOE/RL-2005-64, *Proposed Plan for the 200-CS-1 Chemical Sewer Group Operable Unit*). The proposed plan details the closure options, and it documents the waste sites that will be remediated in accordance with the ROD, to be developed following issuance of the proposed plan.

Four representative waste sites in the 200-CS-1 OU were evaluated in this FS, based on data reported in DOE/RL-2004-17 and other studies. DOE/RL-98-28, Section 2.5, defines a strategy to streamline RIs and focus the CERCLA process to obtain a decision. As identified in DOE/RL-98-28 and DOE/RL-99-44, additional sampling phases conducted post-ROD are meant to augment the RI data, confirm the alternative selection, support the design, and provide information for final site closeout. Confirmatory sampling is conducted to ensure that the representative waste site model used to evaluate the analogous waste site is appropriate to the site conditions and to confirm that the appropriate remedial alternative was selected. Confirmatory sampling also is used to obtain data necessary to design the remedial alternative and refine the cost estimated for the FS. Verification sampling is conducted to demonstrate that the remedial goals have been met by the implementation of the remedial alternative.

Post-ROD sampling will be determined through DQO identification and a sampling and analysis plan that will be developed to direct the necessary sampling. This sampling will be used to confirm that the correct alternative has been selected and to identify possible areas of these waste sites that may or may not need additional remediation.

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Table 9-1. Alternatives for 200-CS-1 Operable Unit Waste Sites. (3 pages)

Waste Site	Alternative				Estimated cost ($ in thousands)	Justification for Suggested Alternative
	Alt. 1 – No Action	② Alt. 2 - MESC/ MNA	Alt. 3 - RTD	Alt. 4 - Eng. Barrier		
216-A-29 Ditch Segment 1	☑				$0	The no-action alternative meets the threshold and balancing criteria for overall protection of human health and the environment. The identified ARARs are not applicable to this segment of the 216-A-29 Ditch because no human health, groundwater pathway, and ecological receptor risk drivers are present. The no-action alternative is readily implementable.
216-A-29 Ditch Segment 2			☑		$2,362	The RTD alternative is as protective of groundwater and ecological receptors as the engineered barrier alternative and provides greater assurance of long-term effectiveness and permanence. The risk drivers are within the top 4.6 m (15 ft). Removal and disposal in the Environmental Restoration Disposal Facility represent an effective use of resources.

Table 9-1. Alternatives for 200-CS-1 Operable Unit Waste Sites. (3 pages)

Waste Site	Alternative				Estimated cost ($ in thousands)	Justification for Suggested Alternative
	Alt. 1 – No Action	② Alt. 2 - MESC/ MNA	Alt. 3 - RTD	Alt. 4 - Eng. Barrier		
216-B-63 Trench		☑			$1,064	The MESC/MNA alternative meets the threshold and balancing criteria for overall protection of human health and the environment. The identified ARARs are not applicable to this site because no human health, groundwater pathway, and ecological receptor risk drivers are present. The MESC/MNA alternative, including the feasible monitoring approach, is readily implementable.
216-S-10 Ditch Covered Portion & Uncovered Segment 1	☑				$0	The no-action alternative meets the threshold and balancing criteria for overall protection of human health and the environment. The identified ARARs are not applicable to these segments because no human health, groundwater pathway, and ecological receptor risk drivers are present. The no-action alternative is readily implementable.
216-S-10 Ditch Uncovered Segment 2			☑		$2,319	The RTD alternative is as protective of groundwater and ecological receptors as the engineered barrier alternative and provides greater assurance of long-term effectiveness and permanence. The risk drivers are within the top 4.6 m (15 ft). Removal and disposal in the Environmental Restoration Disposal Facility represent an effective use of resources.

Table 9-1. Alternatives for 200-CS-1 Operable Unit Waste Sites. (3 pages)

Waste Site	Alternative				Estimated cost ($ in thousands)	Justification for Suggested Alternative
	Alt. 1 – No Action	2 Alt. 2 - MESC/ MNA	Alt. 3 - RTD	Alt. 4 - Eng. Barrier		
216-S-10 Pond (representative site and analogous site 216-S-11 Pond)	☑				$0 and $0	The no-action alternative meets the threshold and balancing criteria for overall protection of human health and the environment. The identified ARARs are not applicable to these sites because no human health, groundwater pathway, and ecological receptor risk drivers are present. The no-action alternative is readily implementable.

ARAR= applicable or relevant and appropriate requirement.
Risk driver= see Section 3.7 for discussion.
MESC= maintain existing soil cover.
MNA = monitored natural attenuation.
RTD = removal, treatment, and disposal.
☑ = Indicates suggested alternative

Table 9-2. Comparison of Alternatives for the 216-A-29 Ditch.

CERCLA Criteria for Evaluation	Alternatives			
	ALT. 1 – NO ACTION	ALT. 2 - MESC/ MNA	ALT. 3 - RTD	ALT. 4 - ENG. BARRIER
216-A-29 Ditch	☑ **Segment 1**		☑ **Segment 2**	
Threshold Criteria				
Overall protection	☑	☐	☑	☑
Compliance with ARARs	☑	☐	☑	☑
Balancing Criteria				
Long-term effectiveness	N/A	N/A	◆	◆
Short-term effectiveness	N/A	N/A	◈	◈
Reduction in toxicity, mobility, or volume	N/A	N/A	◆	◆
Implementability	N/A	N/A	◈	◈
Cost (in thousands)				
Total present worth	$0	N/A	$2,362	$4,339

☑ = Indicates suggested alternative.
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: partially satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
ENG = engineered.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
N/A = not applicable.
RTD = removal, treatment, and disposal.

Table 9-3. Comparison of Alternatives for the 216-B-63 Trench.

CERCLA Criteria for Evaluation	Alternatives			
	ALT. 1 – NO ACTION	**ALT. 2 - MESC/ MNA**	**ALT. 3 - RTD**	**ALT. 4 - ENG. BARRIER**
216-B-63 Trench		☑		
Threshold Criteria				
Overall protection	☐	☑	N/A	N/A
Compliance with ARARs	☐	☑	N/A	N/A
Balancing Criteria				
Long-term effectiveness	☐	◆	N/A	N/A
Short-term effectiveness	◈	◆	N/A	N/A
Reduction in toxicity, mobility, or volume	◇	◆	N/A	N/A
Implementability	◆	◆	N/A	N/A
Cost (in thousands)				
Total present worth	$0	$1,064	N/A	N/A

☑ = Indicates suggested alternative.
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: partially satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
ENG = engineered.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
N/A = not applicable.
RTD = removal, treatment, and disposal.

Table 9-4. Comparison of Alternatives for the 216-S-10 Ditch.

CERCLA Criteria for Evaluation	Alternatives			
	ALT. 1 – NO ACTION	**ALT. 2 - MESC/ MNA**	**ALT. 3 - RTD**	**ALT. 4 - ENG. BARRIER**
216-S-10 Ditch	☑ **Covered Portion & Uncovered Segment 1**		☑ **Uncovered Segment 2**	
Threshold Criteria				
Overall protection	☑	☐	☑	☑
Compliance with ARARs	☑	☐	☑	☑
Balancing Criteria				
Long-term effectiveness	N/A	N/A	◆	◆
Short-term effectiveness	N/A	N/A	⟐	⟐
Reduction in toxicity, mobility, or volume	N/A	N/A	◆	◆
Implementability	N/A	N/A	⟐	⟐
Cost (in thousands)				
Total present worth	$0	N/A	$2,319	$2,916

☑ = Indicates suggested alternative.
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
⟐ = Moderate: partially satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.
ENG = engineered.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
N/A = not applicable.
RTD = removal, treatment, and disposal.

Table 9-5. Comparison of Alternatives for the 216-S-10 Pond.

CERCLA Criteria for Evaluation	Alternatives			
	ALT. 1 – NO ACTION	ALT. 2 - MESC/ MNA	ALT. 3 - RTD	ALT. 4 - ENG. BARRIER
Representative Site 216-S-10 Pond	☑			
Threshold Criteria				
Overall protection	☑	☑	N/A	N/A
Compliance with ARARs	☑	☑	N/A	N/A
Balancing Criteria				
Long-term effectiveness	◈	◈	N/A	N/A
Short-term effectiveness	◈	◈	N/A	N/A
Reduction in toxicity, mobility, or volume	◈	◈	N/A	N/A
Implementability	◆	◈	N/A	N/A
Cost (in thousands)				
Total present worth	$0	$0	N/A	N/A

☑ = Indicates suggested alternative.
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: partially satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
ENG = engineered.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
N/A = not applicable.
RTD = removal, treatment, and disposal.

Table 9-6. Comparison of Alternatives for the 216-11 Pond.

CERCLA Criteria for Evaluation	Alternatives			
	ALT. 1 – NO ACTION	ALT. 2 - MESC/ MNA	ALT. 3 - RTD	ALT. 4 - ENG. BARRIER
Analogous Site 216-S-11 Pond	☑			
Threshold Criteria				
Overall protection	☑	☑	N/A	N/A
Compliance with ARARs	☑	☑	N/A	N/A
Balancing Criteria				
Long-term effectiveness	◈	◈	N/A	N/A
Reduction in toxicity, mobility, or volume	◈	◈	N/A	N/A
Short-term effectiveness	◈	◈	N/A	N/A
Implementability	◆	◈	N/A	N/A
Cost (in thousands)				
Total present worth	$0	$0	N/A	N/A

☑ = Indicates suggested alternative.
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
ENG = engineered.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
N/A = not applicable.
RTD = removal, treatment, and disposal.

10.0 REFERENCES

10 CFR 835, "Occupational Radiation Protection," Title 10, *Code of Federal Regulations*, Part 835.

10 CFR 860, "Trespassing on Department of Energy Property," Title 10, *Code of Federal Regulations*, Part 860.

36 CFR 60, "National Register of Historic Places," Title 36, *Code of Federal Regulations*, Part 60.

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APPENDICES A-H

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DOE/RL-2005-64
DRAFT B - REISSUE

Proposed Plan for the 200-CS-1 Chemical Sewer Group Operable Unit

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Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

United States Department of Energy
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Richland, Washington 99352

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LIST OF TERMS

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (also known as Superfund)
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
CSM	conceptual site model
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant difference
ET	evapotranspiration
Feasibility Study	DOE/RL-2005-63, *Feasibility Study for the 200-CS-1 Chemical Sewer Group Operable Unit*
HAB	Hanford Advisory Board
Implementation Plan	*200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (DOE-RL-98-28)
MESC/MNA/IC	Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls
N/A	not applicable
NCP	"National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300)
NEPA	*National Environmental Policy Act of 1969*
OU	operable unit
Plan	proposed plan
PRG	preliminary remediation goal
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RESRAD	RESidual RADioactivity (dose model)
ROD	Record of Decision
RTD	removal, treatment, and disposal
TBC	to be considered
TBD	to be determined
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a)
TSD	treatment, storage, and/or disposal
WAC	*Washington Administrative Code*

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INTRODUCTION

The 200-CS-1 Operable Unit (OU) waste sites, located on the Central Plateau of the Hanford Site, include two ditches, a trench, and two ponds that were used for waste disposal and pose a potential risk to human health and the environment. To reduce these risks, the waste sites will be cleaned up and/or isolated and controlled (i.e., remedial actions will be implemented). The 200-CS-1 OU waste sites received primarily liquid effluents with low concentrations of contaminants from Hanford Site processing operations in the 200 East and 200 West Areas (shown in Figure 1). The following five waste sites make up the 200-CS-1 OU:

- 216-A-29 Ditch
- 216-B-63 Trench
- 216-S-10 Ditch
- 216-S-10 Pond
- 216-S-11 Pond.

Figure 1. The Hanford Site and Location of the 200-CS-1 Operable Unit Sites.

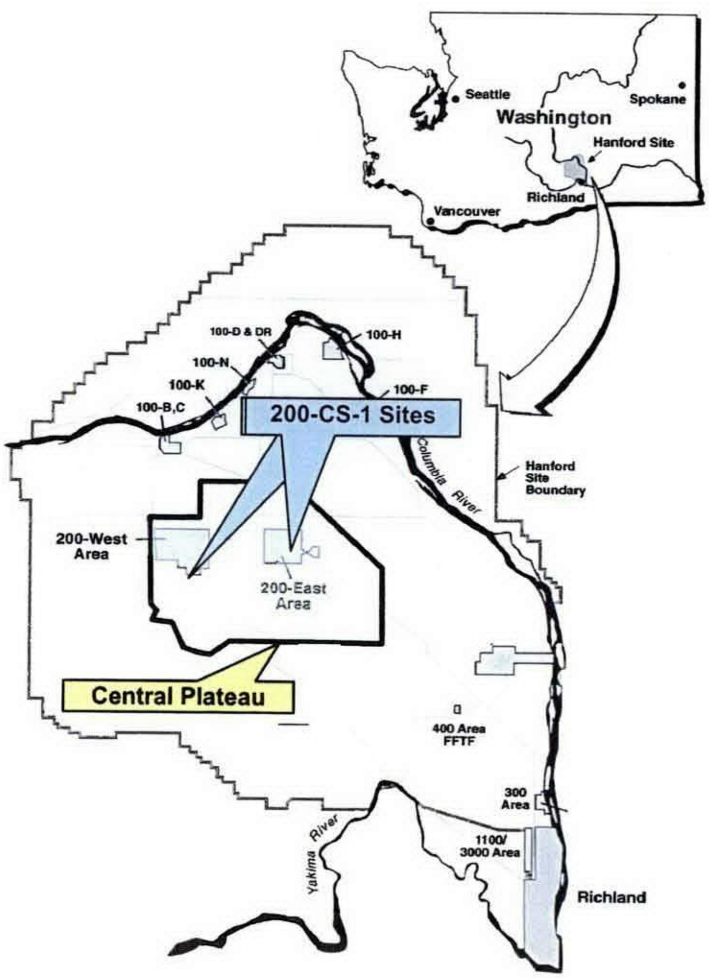
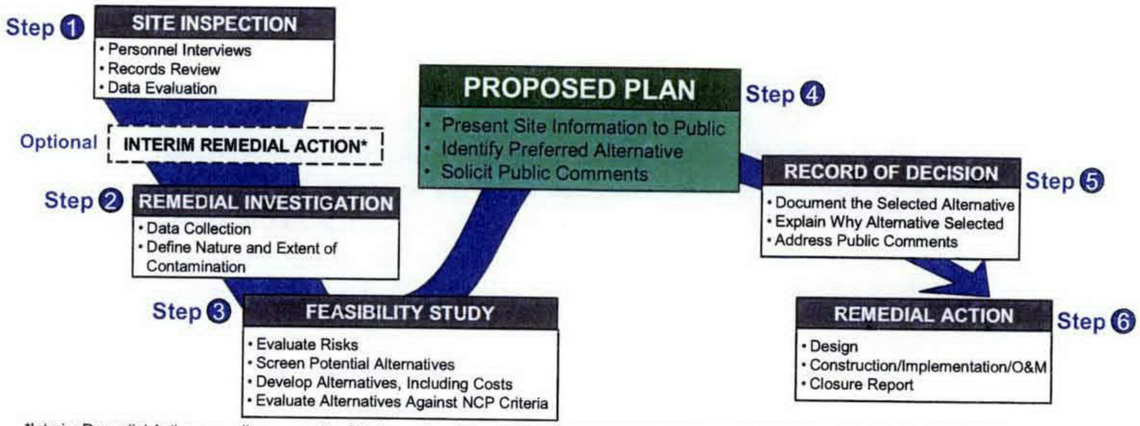


Figure 2. The CERCLA Process.



*Interim Remedial Action normally occurs after Site Inspection, but could occur at any point in the process when a concern has been identified.

NCP = "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300).

Step 1. Site Inspection. "Site inspection" includes interviewing site personnel regarding the history of the site, reviewing waste disposal records, and evaluating existing data.

Step 2. Remedial Investigation. "Remedial investigation" consists of conducting an environmental study to identify the nature and extent of contamination and performing a preliminary evaluation of the risk posed to human health and the environment.

Step 3. Feasibility Study. The "feasibility study" (FS) includes the details of a remedial alternatives evaluation, which includes a complete risk assessment of current conditions and an evaluation of the potential risk reduction presented for each of the remedial alternatives that are considered.

Step 4. Proposed Plan. The "Proposed Plan" (this document) is based on previous field investigations and reports that are completed in the first three steps of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) process described above. The Proposed Plan summarizes the remedial alternative evaluations and presents the preferred alternative recommended in the FS to the public for comments.

Step 5. Record of Decision. The "Record of Decision" (ROD) formally documents the cleanup alternative that was selected after the Tri-Parties (U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology) reviewed and responded to public comments on the Proposed Plan.

Step 6. Remedial Action. "Remedial action" consists of the actual cleanup activities being performed. When cleanup is completed, a final report is written that describes the remedial actions implemented, the result of the actions, and the conclusion of the CERCLA process.

This document presents the Proposed Plan (Plan) for management of the 200-CS-1 OU waste sites. This Plan describes the cleanup alternatives that have been evaluated and identifies the preferred remedial alternative for each waste site. Remedial actions are evaluated in accordance with the requirements of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), also known as Superfund. Four of the five sites—216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, and 216-S-10 Pond—are *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and/or disposal (TSD) units. The 216-S-11 Pond is a past-practice unit. The 200-CS-1 OU has been identified as RCRA past practice in Appendix C of Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). DOE-RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (Implementation Plan) and Tri-Party Agreement Change Request M-015-02-01 documented the change to allow all OUs on the Central Plateau to use the CERCLA past-practice process in lieu of the RCRA past-practice process. The CERCLA past-practice process is identified in Section 7.3 of Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan* (Action Plan), as the CERCLA remedial investigation/feasibility study process. This Plan also identifies how RCRA closure of these sites will be coordinated with the CERCLA remedial actions.

This Plan is issued by the Washington State Department of Ecology (Ecology), the U.S. Environmental Protection Agency (EPA), and the U.S. Department of Energy (DOE). These three agencies, collectively known as the Tri-Parties, are proposing the preferred remedies for these waste sites under the authority of CERCLA and in accordance with the Tri-Party Agreement. CERCLA requires an investigation of site conditions and risks that support determination of the best methods for cleanup. This process is often lengthy and may be conducted in phases. CERCLA environmental investigations and cleanup follow the steps shown in Figure 2. Steps 1 through 3 have been completed for the 200-CS-1 OU at this time. Also incorporated into this Plan are elements necessary to meet DOE's responsibilities under the *National Environmental Policy Act of 1969* (NEPA).

The Tri-Parties are issuing this Plan as part of the public participation responsibilities under Section 117(a) of CERCLA and 40 CFR 300.430(f)(3), "Selection of Remedy," "Community Relations to Support the Selection of Remedy." Final remedies will be selected only after the public comment period has ended and the comments received have been reviewed and considered. The public is encouraged to review and comment on all of the alternatives presented in this Plan. If requested, the Tri-Parties will hold a public meeting to explain the content of this Plan and to obtain additional comments. Responses to comments will be presented in a responsiveness summary that will be part of the Record of Decision (ROD).

Closure plans meeting the requirements of WAC 173-303-610, "Dangerous Waste Regulations," "Closure and Post-Closure," will be developed for each TSD unit. The closure plans will be prepared to support permitting schedules. Public involvement will occur for the DOE/RL-2005-63, *Feasibility Study for the 200-CS-1 Chemical Sewer Group Operable Unit* (Feasibility Study), and this Plan. The public comment period for the TSD unit closure plans will occur in conjunction with the Hanford Site RCRA Permit, WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8, for the Treatment, Storage, and Disposal of Dangerous Waste*, modification. Coordination of RCRA closure activities with the CERCLA remedial action will optimize timing and efficiency and is consistent with the provisions contained in the Tri-Party Agreement (Ecology et al., 1989a). The remediation of the OU, including closure of the TSD units, will be coordinated to minimize overlap and duplication of work. Details of this coordination are provided in Article IV and Sections 5.5, "Treatment, Storage, and Disposal Units and Past-Practice Units Interface," and 6.3, "Treatment, Storage, and Disposal Closure Process," of the Action Plan (Ecology et al., 1989b).

This Plan and TSD unit closure plans are based on key information that can be found in detail in the Feasibility Study (DOE/RL-2005-63) and documents contained in the Administrative Record for the 200-CS-1 OU and the TSD units. These documents provide a comprehensive record of the history, previous studies, and site descriptions considered in the evaluation of remedial alternatives and selection of preferred remedies.

OVERVIEW OF THE PROPOSED PLAN

This Plan proposes remedial actions for the 200-CS-1 OU waste sites. During the remedial investigation phase, four of the five waste sites (216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, and 216-S-10 Pond) were chosen for field investigation. One of these four sites, the 216-S-10 Pond, is very similar to the remaining site, 216-S-11 Pond. The 216-S-10 Pond serves as a representative site for the 216-S-11 Pond for the purposes of alternative evaluation and remedy selection.

Table 1 provides a summary of the key contaminant information pertaining to the waste sites in this Plan, such as risk-based concerns, contaminants, maximum concentrations, and vertical distribution below ground surface (bgs). No human-health COCs were identified. The full evaluation of key contaminants for the waste sites is provided in Chapter 3.0 of the Feasibility Study (DOE/RL-2005-63).

Table 1. Summary of Contaminants that are Greater than Groundwater Protection Screening Levels and Ecological Risk Criteria. (2 Pages)

Site	COCs Greater than Groundwater Protection Screening Levels, WAC 173-340-747	Depth Below Ground Surface, meters (feet)	COPECs that are Greater than Ecological Screening Levels	Depth Below Ground Surface, meters (feet)
216-A-29 Ditch	Cadmium, Mercury, Silver, Nitrate, 1,2- Dichloroethane, Aroclor-1254, Benzo(a)anthracene, Chrysene, Methylene Chloride, Sulfate, Tetrachloroethylene, Uranium-235	1.2 (4) – 1.5 (5)	Aroclor-1254, Cadmium, Selenium, Silver, Dibutylphthalate, Cesium-137, Bis (2-ethylhexyl) phthalate	1.2 (4) – 1.5 (5)
	Aroclor-1254, Mercury, Cadmium, Tributyl phosphate	1.2 (4) – 2.0 (6.5)	Arsenic, Thallium	1.8 (6) – 2.1 (7)
	Cadmium, Mercury, Total Uranium, Methylene Chloride, Uranium-233/234, Uranium-238	2.3 (7.5) – 2.6 (8.5)	Lead, Selenium, Silver, Vanadium	2.3 (7.5) – 2.6 (8.5)
216-B-63 Trench	Benzene, Nitrate	1.5 (5) – 1.8 (6)	Antimony, Selenium	1.2 (4) – 2.0 (6.5)
	Methylene Chloride	2.9 (9.5) – 3.2 (10.5)	Selenium, Total Beta Radiostrontium	2.3 (7.5) – 2.6 (8.5)
	Aroclor-1260	2.4 (8) – 3.2 (10.5)	Selenium, Aroclor-1260, Cesium-137, Strontium-90	2.4 (8) – 3.2 (10.5)
	Cadmium	5.3 (17.5) – 5.8 (19)	Aroclor-1260, Cesium-137, Strontium-90	4.0 (13) – 4.7 (15.5)
216-S-10 Ditch	Mercury, Silver, Aroclor-1254, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene	0.0 (0) – 0.46 (1.5)	Chromium (total), Copper, Silver, Thallium, Zinc, Aroclor-1254, Dibutylphthalate	0.0 (0) – 0.46 (1.5)
	Silver	0.46 (1.5) – 0.91 (3)	Chromium (total), Silver	0.46 (1.5) – 0.91 (3)
			Selenium	2.6 (8.5) – 2.9 (9.5)
216-S-10 Pond*	Chromium (total)	2.7 (9) – 3.0 (10)	Thallium	1.2 (4) – 1.5 (5)
	Chromium (total)	6.1 (20) – 6.4 (21)	Selenium	2.4 (8) – 2.7 (9)
	Chromium (total)	60.0 (197) – 60.7 (199)	Silver	2.7 (9) – 3.0 (10)

Table 1. Summary of Contaminants that are Greater than Groundwater Protection Screening Levels and Ecological Risk Criteria. (2 Pages)

Site	COCs Greater than Groundwater Protection Screening Levels, WAC 173-340-747	Depth Below Ground Surface, meters (feet)	COPECs that are Greater than Ecological Screening Levels	Depth Below Ground Surface, meters (feet)
NOTE: No human-health COCs were identified. Aroclor is an expired trademark. WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection." COC = contaminant of concern. COPEC = contaminant of potential ecological concern. WAC = *Washington Administrative Code*. * Representative site for the 216-S-11 Pond.				

To select preferred remedies, the Tri-Parties evaluated the following alternatives:

- **Alternative 1**. No Action
- **Alternative 2.** Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls (MESC/MNA/IC)
- **Alternative 3.** Removal, Treatment, and Disposal (RTD)
- **Alternative 4.** Engineered Barrier (also known as the capping alternative).

These alternatives were evaluated based on CERCLA-specified criteria and are described in "Summary of Remedial Alternatives" of this Plan. This Plan presents a preferred remedy for each waste site based on this evaluation. Table 2 provides an overview of the selected alternative for each site, including segments, along with estimated present-worth costs. The preferred alternative reduces or manages the identified risks associated with each site: potential risk to ecological receptors and groundwater were identified for the 216-A-29 and 216-S-10 Ditches, short-term risk to the industrial worker due to underground radioactive contamination was identified for the 216-B-63 Trench, and no risks are identified for the 216-S-10 Pond. The combined present-worth cost for implementing the 200-CS-1 OU preferred alternatives is estimated to be approximately $5.6 million, based on the CERCLA requirement of +50% / -30% accuracy.

Table 2. Preferred Alternatives for 200-CS-1 Operable Unit Waste Sites. (2 Pages)

Waste Site	Alternative				Estimated cost* ($ in thousands)	Justification for Preferred Alternative
	① No Action	② MESC/ MNA/IC	③ RTD	④ Engineered Barrier		
216-A-29 Ditch Segment 1	☑				$0	The no-action alternative meets the threshold and balancing criteria for overall protection of human health and the environment. The identified ARARs are not applicable to this segment of the 216-A-29 Ditch because no human health, groundwater pathway, or ecological receptor risk drivers are present. The no-action alternative is readily implementable.

Table 2. Preferred Alternatives for 200-CS-1 Operable Unit Waste Sites. (2 Pages)

Waste Site	Alternative				Estimated cost* ($ in thousands)	Justification for Preferred Alternative
	① No Action	② MESC/ MNA/IC	③ RTD	④ Engineered Barrier		
216-A-29 Ditch Segment 2			☑		$2,300	The RTD alternative is as protective of groundwater and ecological receptors as the engineered barrier alternative and provides greater assurance of long-term effectiveness and permanence. The COCs are within the top 4.6 m (15 ft). Removal and disposal in the Environmental Restoration Disposal Facility represent an effective use of resources.
216-B-63 Trench		☑			$1,000	The MESC/MNA/IC alternative meets the threshold and balancing criteria for overall protection of human health and the environment. This alternative would provide long-term effectiveness based on the results of the additional RESRAD modeling. The MESC/MNA/IC alternative, including the feasible monitoring approach, is readily implementable.
216-S-10 Ditch Covered Portion, Segment 1	☑				$0	The no-action alternative meets the threshold and balancing criteria for overall protection of human health and the environment. The identified ARARs are not applicable to these segments because no human health, groundwater pathway, or ecological receptor risk drivers are present. The no-action alternative is readily implementable.
216-S-10 Ditch Segment 2			☑		$2,300	The RTD alternative is as protective of groundwater and ecological receptors as the engineered barrier alternative and provides greater assurance of long-term effectiveness and permanence. The COCs are within the top 4.6 m (15 ft). Removal and disposal in the Environmental Restoration Disposal Facility represent an effective use of resources.
216-S-10 Pond (representative site and analogous site 216-S-11 Pond)	☑				$0 and $0	The no-action alternative meets the threshold and balancing criteria for overall protection of human health and the environment. The identified ARARs are not applicable to these sites because no human health, groundwater pathway, or ecological receptor risk drivers are present. The no-action alternative is readily implementable.

*Present-worth (discounted) estimates are a rough order of magnitude and can be 30% under or 50% over due to uncertainties.

ARAR = applicable or relevant and appropriate requirement.
COC = contaminant of concern.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
IC = institutional controls.
RTD = removal, treatment, and disposal.

The remaining sections of this Plan provide information on the following:

- Background of the 200-CS-1 OU
- Scope and role of the proposed actions, including strategies used to characterize the waste sites, and regulatory requirements and goals for the remedial actions
- Site risks
- Remedial action objectives (RAO) and preliminary remediation goals (PRG)
- Summaries and evaluations of remedial alternatives
- Preferred alternatives for the different waste sites
- Strategies for streamlining future actions (plug-in approach)
- Cleanup strategy for the RCRA TSD unit closure
- Public participation.

SITE BACKGROUND

Hanford Site

The Hanford Site (Figure 1) is a 1,517 km^2 (586-mi^2) Federal facility located in southeastern Washington State along the Columbia River. From 1943 to 1990, the primary mission of the Hanford Site was the production of nuclear materials for national defense. The production mission resulted in the construction of many processing and support facilities along with the generation of large volumes of liquid and solid wastes that remain to be cleaned up. In July 1989, the 100, 200, 300, and 1100 Areas of the Hanford Site were placed on the National Priorities List (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List") pursuant to CERCLA. Waste sites in the 200-CS-1 OU are located in the 200 Areas in the portion of the Hanford Site referred to as the Central Plateau.

Central Plateau

The Central Plateau, occupying approximately 195 km^2 (75 mi^2) in the central portion of the Hanford Site, served as the center for nuclear material processing. The Central Plateau is divided into three areas: 200 East Area, 200 West Area, and 200 North Area. Operations in the 200 East and 200 West Areas were related to chemical separation, plutonium and uranium recovery, processing of fission products, and waste partitioning. The 200 North Area was used for the interim storage and staging of irradiated fuel. Major chemical processes in the Central Plateau resulted in delivery of high-activity waste streams to systems of large underground tanks called "tank farms." Low-activity liquid wastes were discharged to trenches, cribs, drains, ditches, and ponds. The groundwater is approximately 80 m (270 ft) bgs in the 200 East Area and approximately 60 m (200 ft) bgs in the 200 West Area. The groundwater underlying the Central Plateau has been contaminated by a variety of past-practice activities during operations at the Hanford Site.

200-CS-1 Operable Unit Characteristics

The 200-CS-1 OU includes five soil waste sites resulting from discharges to chemical sewers from the Reduction-Oxidation Plant, the Plutonium-Uranium Extraction Plant, and the 1970s cesium/strontium recovery operations at the B Plant. Chemical sewer streams were intended to serve nonradioactive operations in areas such as operating galleries, service areas, aqueous makeup galleries, and maintenance areas.

The plants discharged out-of-specification chemical batches, noncontaminated floor drain waste liquids, nonradiological process wastes, non-process steam condensates, and noncontaminated vessel coil wastes, as well as raw water to dilute chemical additions. These streams became contaminated with generally low levels of radionuclides resulting from unspecified process upsets.

The two ponds were constructed from natural depressions that covered several acres, allowing large volumes of liquid effluent to collect and gradually percolate into the soil column. The ditches were long, narrow channels used to convey large volumes of liquid effluent to one of the ponds or another soil-based liquid disposal site. The trench operated similarly to a long, narrow, and relatively shallow pond.

Additional information about these sites is contained in Table 3 of this Plan and in Chapter 2.0 of the Feasibility Study (DOE/RL-2005-63).

Table 3. 200-CS-1 Operable Unit Waste Sites. (2 Pages)

Waste Site	Dimensions	Operating Period	Effluent Volume Discharged to Site	Background
216-A-29 Ditch	1220 m long 1.8 m wide 0.6 – 4.6 m deep ---- 4,000 ft long 6 ft wide 2 – 15 ft deep	1955 to 1991	Nominal 22,700,000 L/day ---- 6,000,000 gal/day	The 216-A-29 Ditch received liquid effluents from the Plutonium-Uranium Extraction Plant chemical sewer. The site includes the open unlined ditch, a concrete spillway covering the first 3 m (10 ft) of the ditch, a culvert that routed the ditch under a road, and a flow control structure near the ditch exit to the 216-B-3-3 Ditch (in the 200-CW-1 Operable Unit). Limited stabilization, consisting of pushing contaminated soils into the bottom of the ditch and backfilling the ditch with clean fill, was performed after the ditch was taken out of service.
216-B-63 Trench	427 m long 1.2 m wide 3 m deep ---- 1,400 ft long 4 ft wide 10 ft deep	1970 to 1992	378,000 – 1,400,000 L/day ---- 100,000 – 400,000 gal/day	The 216-B-63 Trench received emergency cooling water and chemical sewer discharges from the B Plant via the 207-B Retention Basin (in the 200-CW-1 Operable Unit). The site includes the open, unlined trench with rock fill in the first 3 m (10 ft), a 1.5 m (5-ft) inlet pipe approximately 1 m (3 ft) below grade, and a weir box used for flow control at the inlet. Previous cleanup was performed in 1970 when the bottom and sides were dredged out. Contaminated soil from that dredging was disposed of in the 218-E-12B Burial Ground. The trench was backfilled with clean soil after it was taken out of service.
216-S-10 Ditch	686 m long 1.8 m wide 1.8 m deep ---- 2,250 ft long 6 ft wide 6 ft deep	1951 to 1991	Nominal maximum 568,000 L/day ---- 150,000 gal/day	The 216-S-10 Ditch received wastewater from Reduction-Oxidation Plant operations. The site includes the open, unlined ditch and several pits adjacent to the ditch used for disposal of contaminated sediment dredged from the ditch in 1955. The ditch originally was used as the disposal site for the wastewater from the Reduction-Oxidation Plant. The 216-S-10 and 216-S-11 Ponds were added in 1954 to provide additional capacity. The volume of wastewater generated subsided by 1984 so the additional ponds no longer were needed. Parts of the ditch were backfilled with clean soil in 1984.
Representative Site 216-S-10 Pond	Irregular shape Approximately 20,200 m^2 2.4 m deep ---- 5 acres 8 ft deep	1954 to 1984	Nominal maximum 568,000 L/day ---- 150,000 gal/day	The 216-S-10 Pond received Reduction-Oxidation Plant wastewater via the 216-S-10 Ditch. The pond is unlined and includes four finger-shaped trenches. The pond was backfilled with clean soil in 1984 concurrent with a portion of the 216-S-10 Ditch.

Table 3. 200-CS-1 Operable Unit Waste Sites. (2 Pages)

Waste Site	Dimensions	Operating Period	Effluent Volume Discharged to Site	Background
Analogous site 216-S-11 Pond	Irregular shape ~6,000 m^2 ---- 1.5 acres	1954 to 1965	Nominal maximum 568,000 L/day ---- 150,000 gal/day	The 216-S11 Pond received Reduction-Oxidation Plant wastewater via the 216-S-10 Ditch. The pond is unlined and consists of two interconnecting lobes. The south lobe was backfilled with clean soil in 1975. The entire site was surface stabilized in 1983.

Very low levels of fission products, plutonium, and small quantities of uranium were discharged to these sites, except for the 216-S-10 Ditch system where more than 215 kg (474 lb) of uranium were reportedly discharged. Contaminant inventories for these streams are not well documented because there were few requirements for sampling of nonradioactive effluent streams for most of the operating period of these sites. Chemical discharges reported to the 200-CS-1 OU waste sites included chemicals used in the plant processes, such as aluminum nitrate, hydrazine, sodium nitrate, sodium hydroxide, sodium phosphate, sodium fluoride, sodium carbonate, sodium nitrite, potassium chromate, potassium permanganate, potassium hydroxide, sulfuric acid, oxalic acid, nitric acid, hydrogen peroxide, and calcium nitrate. Various organic process chemicals were discharged into the sewer stream, although in small amounts.

SCOPE AND ROLE OF ACTION

This Plan presents proposed remedial actions for contaminated soils and components (e.g., concrete, pipelines) associated with liquid waste disposal sites in the 200-CS-1 OU. In accordance with CERCLA requirements, waste sites within the OU were investigated to determine contaminants of concern (COC) and the potential risk to human health and the environment. RAOs, which define the acceptable risk to human health and the environment, were established based on reasonably anticipated future land use, potential applicable or relevant and appropriate requirements (ARAR), and site-specific considerations.

Alternative remedies were evaluated to determine the specific remedial action necessary to ensure that risks to human health and the environment meet the RAOs. The preferred alternative for each waste site is selected because it addresses existing and potential future threats to human health and the environment from waste site contaminants and best meets the CERCLA evaluation criteria.

Remediation of 200-CS-1 OU waste sites is a source control action that will protect the groundwater OUs (200-BP-5, 200-PO-1, and 200-UP-1) from future contamination. The scope of this Plan does not include remediation of the groundwater beneath these waste sites.

Monitoring and treatment of the groundwater is ongoing as part of the Hanford Site Soil & Groundwater Remediation Project.

Remedial actions for other waste sites adjacent to the 200-CS-1 OU sites are being evaluated in accordance with commitments established in the Tri-Party Agreement (Ecology et al., 1989a).

Characterization Approach

Waste sites within the 200-CS-1 OU are classified as either representative waste sites or analogous waste sites based on individual site characteristics. Of the five waste sites in the 200-CS-1 OU, four are representative waste sites and one is an analogous waste site. The four representatives sites for the 200-CS-1 OU—216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, and 216-S-10 Pond—were identified in DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*, and the Implementation Plan (DOE/RL-98-28). The 216-S-10 Pond serves as a representative site for the 216-S-11 Pond (analogous waste site) for the purposes of alternative evaluation and remedy selection.

During the remedial investigation, four of the five waste sites—216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, and 216-S-10 Pond—were chosen for field investigation. These sites are RCRA TSD units and were characterized to comply with RCRA closure requirements. The 216-A-29 Ditch represented the anticipated "worst case" level and extent of contamination based on reported discharges and inventory. Detailed characterization data are contained in DOE/RL-2004-17, *Remedial Investigation Report for the 200-CS-1 Chemical Sewer Group Operable Unit.*

The 216-S-10 Pond is representative of the remaining site, 216-S-11 Pond, because it served the same function, is similar geologically, and received waste from the same source. Characteristics of the 216-S-10 Pond, as well as the impact on human health and the environment, are considered representative of the characteristics and impact of the 216-S-11 Pond. Findings and conclusions from the investigation of this representative site are used to evaluate remedial action alternatives for the similar, or analogous, waste sites. As discussed in the Implementation Plan (DOE/RL-98-28), this analogous site approach streamlines the investigation process by grouping similar sites together.

Confirmatory site investigations (additional sampling and analysis) are conducted through the remedial design/remedial action to confirm the accuracy of the conceptual site models (CSM)/site conditions. Confirmatory samples will be taken at the analogous site, 216-S-11 Pond, where the remedy was selected based on conclusions drawn from the evaluation of the 216-S-10 Pond. The confirmatory sampling approaches applicable to the preferred remedies (Alternatives 1 through 4) are described below.

For those waste sites where No Action (Alternative 1) or MESC/MNA/IC (Alternative 2) is the preferred remedy, confirmatory data typically will be collected to confirm the assumptions of the CSM and verify the nature and/or vertical extent of contamination. Site-specific data needs will be specified in the sampling and analysis plan.

For those waste sites where RTD (Alternative 3) is the preferred remedy, confirmatory data will be collected to confirm the remedy using an observational approach, samples will be taken from the open excavation during various stages of the removal, and verification samples will be collected at the proposed end of excavation.

For those waste sites where an Engineered Barrier (Alternative 4) is the preferred remedy, verification data will be collected to support design activities, as well as to confirm the assumptions of the CSM and the horizontal extent of contamination.

Land Use

The DOE is expected to continue industrial-exclusive land-use activities on the Central Plateau for at least 50 years in accordance with DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, and 64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)." Site risks were evaluated based on a reasonably anticipated future land use for the Central Plateau. These evaluations were based on the criteria presented in, and are consistent with, the Tri-Parties' response (Klein et al., 2002, "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area") to Hanford Advisory Board (HAB) Advice #132 (HAB 132, "Exposure Scenarios Task Force on the 200 Area"). The inclusion of the S Ponds and the B Pond in the Core Zone was based on the following: the need to expand the Core Zone to include the footprint of the Waste Treatment Plant (Vitrification Plant) and the need to avoid splitting waste sites of anticipated similar closure strategies.

Based on this documentation and current Central Plateau assumptions, the alternative evaluations considered the following anticipated land-use requirements.

- The Core Zone will have an industrial scenario for the foreseeable future. The evaluation considers the following uses:
  - Industrial-exclusive use for the next 50 years (through 2050)
  - Industrial land use (non-DOE worker) for 100 years after 2050 (through 2150)
  - Industrial land use post-150 years.
- Groundwater contamination under the Core Zone will preclude beneficial use for the foreseeable future. This evaluation considers the following:
  - No consumptive use of groundwater for the next 150 years, based on the expected period of waste management
  - Any selected remedy will provide for no further degradation of groundwater from the 200-CS-1 OU waste sites
  - No drilling for water or other purposes will be allowed in the Core Zone, except as part of monitoring or cleanup plan approved by EPA and Ecology.

In addition, risks were calculated and evaluated considering the possibility of intruders 150 years from now (2150).

Applicable or Relevant and Appropriate Requirements

ARARs are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated into Federal or state law or regulation that:

- Specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site; or
- Address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

Additional standards that have not been promulgated into law or regulation can be used as "To Be Considered" (TBC) criteria.

More detailed discussion of the potential ARARs and TBCs associated with the 200-CS-1 OU waste sites are included in Appendix G of the Feasibility Study (DOE/RL-2005-63). Key potential ARARs and TBCs used for the remedy selection for the 200-CS-1 OU sites are as follows:

- WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties," which identifies contaminant concentrations in soil that are protective of human health
- WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection," which identifies contaminant concentrations in soils that are protective of groundwater
- EPA/540/R-99/006, *Radiological Risk Assessment at CERCLA Sites: Q & A*, which identifies a dose rate limit of 15 mrem/yr above background to achieve the excess lifetime cancer risk threshold of 1×10^{-6} to 1×10^{-4}
- DOE-STD-1153-2002, *A Graded Approach to Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, which identifies radionuclide concentrations in soil that are protective of the ecological habitat

- WAC 173-340-900, "Tables," Table 749-3, "Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals," which identifies chemical concentrations in soil that are protective of ecological receptors.

SUMMARY OF SITE RISKS

Estimated risks were based on the RAOs and current site information. The Tri-Parties will use an industrial-exposure scenario to assess risks in the Core Zone of the Central Plateau. This exposure scenario includes the assumption that groundwater under the Central Plateau will not be used for 150 years. This exposure scenario does not preclude remedial decisions for groundwater OUs that may establish a different restoration timeframe. The findings of the risk evaluation for the 200-CS-1 OU are summarized as follows.

- The 200-CS-1 OU sites are not highly contaminated. Contamination is not widespread, concentrations are not particularly elevated, and concentrations that are elevated are in localized areas.
- Significant portions of the sites are not affected or exhibit contaminant concentrations comparable to background.
- No COCs were identified for the direct-contact pathway under an industrial land-use scenario in the risk assessment.
- The risk assessment found that contaminants at segments of the 216-A-29 Ditch and the 216-S-10 Ditch posed a potential impact to groundwater.
- The screening-level ecological risk assessment found that contaminants of potential ecological concern (COPEC) located in segments at the 216-A-29 Ditch and the 216-S-10 Ditch waste sites suggest a potential adverse health effect to ecological receptors exists.

Table 4 provides a summary of site risks identified during the risk assessment using site-specific fate and transport analysis and provides a basis for action under CERCLA.

Table 4. Summary of Site Risks from 200-CS-1 Operable Unit Sites. (2 Pages)

Waste Site*	Risk-Based Concern	Summary of Risk Drivers	Basis for Action
216-A-29 Ditch	Ecological Receptors & Groundwater Protection Segment 2	Aroclor-1254, Cadmium, 1,2 Dichloroethane, Benzo(a)anthracene, Chrysene, Cesium-137, Bis (2-ethylhexyl) phthalate, Silver, and Tetrachloroethylene (1.2 - 1.5 m [4 - 5 ft]) bgs Aroclor-1254, Cadmium, and Tributyl phosphate (1.2 – 2.0 m [4 – 6.5 ft]) bgs	Yes
216-B-63 Trench	Risk to Industrial Worker	Radiological contaminants	Yes
216-S-10 Ditch	Ecological Receptors & Groundwater Protection-Segment 2	Aroclor-1254, Chromium (total), Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, and Silver (0 – 0.46 m [0 – 1.5 ft]) bgs Chromium (total) and Silver (0.46 – 0.91 m [1.5 – 3 ft]) bgs	Yes

Table 4. Summary of Site Risks from 200-CS-1 Operable Unit Sites. (2 Pages)

Waste Site*	Risk-Based Concern	Summary of Risk Drivers	Basis for Action
Representative Site 216-S-10 Pond and analogous site 216-S-11 Pond	N/A	N/A	No

*Level of risk associated with direct exposure to chemicals is less than regulatory criteria.
Aroclor is an expired trademark.
bgs = below ground surface.
N/A = not applicable.

In addition to the risk analysis required by CERCLA, the Tri-Parties have elected to evaluate and provide information on additional risk scenarios considering an inadvertent intruder and alternative land use scenarios. This evaluation is consistent with the framework identified in the Tri-Parties' response to HAB 132. The inadvertent intruder scenario assumes that institutional controls could be lost 100 years after closure of disposal facilities containing radioactive waste (50 years of industrial-exclusive use is presumed to end in 2050 and 100 years of institutional controls will end in 2150). The acceptable regulatory exposure guideline is 15 mrem/yr. Two unrestricted land-use exposure scenarios and three inadvertent intruder scenarios were evaluated. The unrestricted land-use exposure scenarios include a rural residential scenario and a tribal-use scenario (i.e., the Confederated Tribes of the Umatilla Indian Reservation Traditional Subsistence Lifeways scenario). The three inadvertent intruder scenarios evaluated include a construction trench worker, a well driller, and a rural resident exposed to drill cuttings. Scenario evaluations were conducted for the 216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, and 216-S-10 Pond. Based on analysis no impacts were reported for each of the scenarios evaluated. Additional detail can be found in Appendix B of the Feasibility Study (DOE/RL-2005-63).

REMEDIAL ACTION OBJECTIVES

The following RAOs were developed taking into consideration information currently available for the 200-CS-1 OU and the Central Plateau. Two sets of RAOs were developed from this information to capture the remedial objectives of the Central Plateau, 200 Areas and to capture the specific waste sites' remedial objectives. The specific RAOs identified for the waste sites are based on the evaluation of reasonably anticipated future land uses, conceptual models for exposure pathways, ARARs, and TBC criteria. RAOs are general statements describing what the remedial action is expected to accomplish while protecting human health and the environment. RAOs are defined as specifically as possible and consider the following variables:

- Media of interest (e.g., contaminated soil, solid waste)
- Types of contaminants (e.g., radionuclides, inorganic and organic chemicals)
- Potential receptors (e.g., humans, animals, plants)
- Possible exposure pathways (e.g., external radiation, ingestion)
- Levels of residual contaminants that may remain following remediation (i.e., contaminant levels below cleanup standards or below a range of levels for different exposure routes).

Development of PRGs for the 200-CS-1 OU will be based on the following RAOs, which encompass the remediation objectives for the Central Plateau, 200 Areas.

- **RAO 1.** Prevent unacceptable risk to human health and ecological receptors from exposure to soils and/or debris contaminated with nonradiological constituents at concentrations above the industrial-use criteria, as defined in WAC 173-340-745(5), "Soil Cleanup Standards for Industrial Properties," "Method C Industrial Soil Cleanup Levels," for human health, or the screening criteria in WAC 173-340-7493, "Site-Specific Terrestrial Ecological Evaluation Procedures" for ecological receptors.

- **RAO 2.** Prevent unacceptable risk to human health and ecological receptors from exposure to soils and/or debris contaminated with radiological constituents by:
  - Preventing exposure to radiological constituents at concentrations that will cause a dose rate limit of 15 mrem/yr above background for industrial workers (EPA/540/R-99/006). A dose rate limit of 15 mrem/yr above background generally achieves the EPA excess lifetime cancer risk threshold, which ranges from 1×10^{-6} to 1×10^{-4}.
  - Protecting ecological receptors based on a dose rate limit of 1.0 rad/d for aquatic animals and terrestrial plants and 0.1 rad/d for terrestrial animals (DOE-STD-1153-2002), which is a TBC criterion.
- **RAO 3.** Prevent migration of hazardous chemical contaminants through the soil column to groundwater or reduce soil concentrations below WAC 173-340-747 groundwater protection criteria so that no further degradation of the groundwater results from contaminant leaching from the soil.
- **RAO 4.** Prevent migration of radioactive contaminants through the soil column to groundwater protection criteria (40 CFR 141.62, "National Primary Drinking Water Regulations") so that no further degradation of the groundwater results from contaminant leaching from the soil. Protection of the Columbia River from contaminants in this OU is achieved through RAO 3; there is no surface water in the immediate vicinity of the waste sites that requires a separate RAO.
- **RAO 5.** Prevent adverse impacts to cultural resources and threatened or endangered species and minimize wildlife habitat disruption.
- **RAO 6.** Prevent or reduce occupational health risks to workers performing remedial actions.
- **RAO 7.** Ensure that appropriate institutional controls and monitoring requirements are established to protect future users of the remediated waste sites.

Based on the human health, ecological, and groundwater pathway risks, in addition to achieving the Central Plateau, 200 Areas RAOs presented above, additional RAOs for the 200-CS-1 OU by waste site have been developed. Specific RAOs for each waste site further refine the PRGs based on the COCs and COPECs present at each waste site. The site-specific RAOs for each waste site are as follows.

- **216-A-29 Ditch**
  - **RAO 1.** Prevent unacceptable risk to ecological receptors from exposure to soils and/or debris contaminated with nonradiological constituents.
  - **RAO 2.** Prevent unacceptable risk to ecological receptors from exposure to soils and/or debris contaminated with radiological constituents. Prevent unacceptable dose to industrial workers from exposure to soils contaminated with radiological constituents.
  - **RAO 3.** Prevent migration of nonradiological hazardous chemical contaminants through the soil column to groundwater.
- **216-B-63 Trench**
  - **RAO 2.** Prevent unacceptable dose to industrial workers from exposure to soils contaminated with radiological constituents.

- **216-S-10 Ditch**
  - **RAO 1.** Prevent unacceptable risk to ecological receptors from exposure to soils and/or debris contaminated with nonradiological constituents.
  - **RAO 3.** Prevent migration of nonradiological hazardous chemical contaminants through the soil column to groundwater.
- **216-S-10 and 216-S-11 Ponds**
  - There are no RAOs for the 216-S-10 or 216-S-11 Ponds because there are no unacceptable risks at these locations.

These RAOs, discussed in Chapter 4.0 of the Feasibility Study (DOE/RL-2005-63), were used to develop the PRGs discussed below.

Preliminary Remediation Goals

PRGs were developed to establish residual soil concentrations for individual contaminants that are protective of human health and the environment. PRGs are established for each of the COCs to guide remedial action and demonstrate that the RAOs have been met. PRGs were developed in the Feasibility Study (DOE/RL-2005-63) screening process, which compared the observed constituent concentrations at the waste sites to the following concentrations:

- Naturally occurring levels
- Radiological dose exposure limits
- Cleanup levels consistent with the RAOs.

A detailed evaluation of the contaminants of potential concern (COPC) and COCs from which to derive the PRGs is contained in Chapter 3.0 of the Feasibility Study (DOE/RL-2005-63). The list of COPCs developed for the waste sites was based on process history and characterization information. Although PRGs were developed for each of the COPCs, it should be emphasized that they are listed as *potential contaminants*; all are not greater than the PRGs or associated RAOs for the evaluated waste sites. Contaminants that are greater than one or more of the RAOs will be retained as COCs.

Numeric soil PRGs were developed to address protection of human health, ecological receptors, and groundwater. The most restrictive (lowest) PRG was selected to determine if site remediation was needed, because it would be protective of all exposure pathways. Following the consideration of comments received during the public comment period, the final remedial action goals or cleanup levels for the 200-CS-1 OU waste sites will be issued in the ROD. Table 5 summarizes the PRGs developed for the 200-CS-1 OU. Each contaminant listed in Table 5 is considered a risk driver for justification of a remedial action at the 216-A-29 and 216-S-10 Ditches.

Table 5. Preliminary Remediation Goals for the 200-CS-1 Operable Unit.

COC/COPEC	PRG_{soil}	Basis
Aroclor-1254	3,230 (µg/kg)[a] 1,306.88 (µg/kg)[b]	Protection of ecological receptors and groundwater at the 216-A-29 Ditch based on WAC 173-340-900.
1,2 Dichloroethane	2.32 (µg/kg)[b]	Protection of groundwater at the 216-A-29 Ditch based on WAC 173-340-900.
Benzo(a)anthracene	86.3 (µg/kg)[b]	Protection of groundwater at the 216-A-29 Ditch based on WAC 173-340-900.
Bis (2-ethylhexyl) phthalate	852 (µg/kg)[a]	Protection of ecological receptors at the 216-A-29 Ditch based on WAC 173-340-900.
Cadmium	0.69 (mg/kg)[b]	Protection of groundwater at the 216-A-29 Ditch based on WAC 173-340-900.
Cesium-137	20 (pCi/g)[a]	Protection of ecological receptors at the 216-A-29 Ditch based on WAC 173-340-900.
Chrysene	95.9 (µg/kg)[b]	Protection of groundwater at the 216-A-29 Ditch based on WAC 173-340-900.
Silver	4.2 (mg/kg)[a]	Protection of ecological receptors at the 216-A-29 Ditch based on WAC 173-340-900.
Tetrachloroethylene	0.867 (µg/kg)[b]	Protection of groundwater at the 216-A-29 Ditch based on WAC 173-340-900.
Tributyl phosphate	32.4 (µg/kg)[b]	Protection of the groundwater at the 216-A-29 Ditch based on WAC 173-340-900.
Aroclor-1254	3,230 (µg/kg)[a] 1,310 (µg/kg)[b]	Protection of ecological receptors and groundwater at the 216-S-10 Ditch based on WAC 173-340-900.
Chromium (total)	67 (mg/kg)[a]	Protection of ecological receptors at the 216-S-10 Ditch based on WAC 173-340-900.
Benzo(a)anthracene	86.3 (µg/kg)[b]	Protection of groundwater at the 216-S-10 Ditch based on WAC 173-340-900.
Benzo(a)pyrene	233 (µg/kg)[b]	Protection of groundwater at the 216-S-10 Ditch based on WAC 173-340-900.
Benzo(b)fluoranthene	288 (µg/kg)[b]	Protection of groundwater at the 216-S-10 Ditch based on WAC 173-340-900.
Benzo(k)fluoranthene	288 (µg/kg)[b]	Protection of groundwater at the 216-S-10 Ditch based on WAC 173-340-900.
Chrysene	95.9 (µg/kg)[b]	Protection of groundwater at the 216-S-10 Ditch based on WAC 173-340-900.
Silver	4.2 (mg/kg)[a]	Protection of ecological receptors at the 216-S-10 Ditch based on WAC 173-340-900.

WAC 173-340-900, "Tables."

[a]Values are based on soil indicators for terrestrial wildlife.

[b]Values are based on soil cleanup level for the protection of groundwater obtained from Ecology, 2005, *Cleanup Levels & Risk Calculations* (CLARC) database, available on the Internet at https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx .

Aroclor is an expired trademark.

COC = contaminant of concern.
COPEC = contaminant of potential ecological concern.
N/A = not applicable.
PRG = preliminary remediation goal.
WAC = *Washington Administrative Code*.

Summary of Remediation Objectives

The human health and screening-level ecological risk assessments, which are fundamental to the scope and role of the actions in this Plan, were performed in accordance with CERCLA. A CSM was developed for the waste sites, and potential risks to human health and ecological receptors were evaluated in a risk assessment for the representative sites, as discussed in the Feasibility Study (DOE/RL-2005-63). The Tri-Parties believe that remedial action is necessary at the waste sites addressed by this Plan to protect human health and the environment from actual or potential exposure of hazardous substances. Such exposures, or potential exposures, could present an imminent and substantial danger to public health, welfare, or the environment.

SUMMARY OF REMEDIAL ALTERNATIVES

Significant analyses and evaluations have contributed to defining applicable technologies and process options to address the waste sites associated with the 200-CS-1 OU. The contaminants, waste form, and waste location were considered as part of this process. Technologies and process options were identified and evaluated based on their ability to reduce potential risks to human health and the environment at the waste sites.

Collective experience gained from previous studies and evaluations of cleanup methods at the Hanford Site were used to identify technologies that could be carried forward as remedial alternatives to address the RAOs. The Feasibility Study (DOE/RL-2005-63) identified four remedial alternatives for detailed and comparative analyses.

- **Alternative 1, No Action.** The no-action alternative represents a situation where no legal restrictions, access controls, or active remedial measures are applied to the site. In the no-action alternative, the existing contaminated soil remains in place. No action implies "walking away" from the waste site and allowing the wastes to remain in place. Confirmation sampling is performed to confirm that the no-action decision is protective. The no-action alternative generally is not selected unless a site poses no unacceptable risk to human health and the environment.
- **Alternative 2, MESC/MNA/IC.** Existing soil covers (e.g., the clean fill placed over the waste site to stabilize it) are maintained as needed to provide protection from intrusion by plants and burrowing animals (e.g., badgers). In addition, institutional controls (e.g., deed restrictions, land-use zoning, and excavation permits) are put in place to prevent human access to the site. The existing soil cover is relied upon to break the exposure pathway until monitored natural attenuation reduces contaminant levels in place by physical, biological, and/or chemical processes such as radioactive decay. Monitoring would be conducted to demonstrate that natural attenuation is occurring and that contamination is remaining in place as concentrations decrease. Active institutional controls will be maintained for up to 150 years, or the time at which radioactivity decays to levels that comply with the RAOs.
- **Alternative 3, RTD.** Structures and soils with contaminant concentrations greater than the RAOs are excavated, using available data and the observational approach, followed by verification sampling, treated as necessary and disposed of in an approved disposal facility such as the Environmental Restoration Disposal Facility (ERDF) in accordance with established waste acceptance criteria. Some materials (e.g., non-hazardous debris) may be disposed of off the Hanford Site, as appropriate. Any material that is greater than the disposal facility waste acceptance criteria would be stored on the Hanford Site (consistent with storage requirements) until the material is treated to meet appropriate waste acceptance criteria. As the contaminated material is excavated, it is characterized and segregated before being transported for disposal. Excavation would continue until contaminated material that is greater than the RAOs is removed and the site is backfilled with clean material. The surface would be recontoured and revegetated to be compatible with surrounding natural areas or other features.
- **Alternative 4, Engineered Barrier.** This alternative consists of constructing engineered surface barriers over contaminated waste sites to control the amount of water that infiltrates into the site to

reduce or eliminate contaminant leaching to groundwater. In addition to their hydrological performance, engineered barriers also can function as physical obstacles to prevent intrusion by human and ecological receptors, limit wind and water erosion, and provide radiation shielding. Engineered barriers (e.g., evapotranspiration [ET] barrier) rely on the water-holding capacity of soil, evaporation from the near-surface, and plant transpiration to control water movement through the engineered barrier. Site-specific engineered barrier designs will be developed as part of the remedial design process and will consider the RAOs and other requirements defined in the ROD, regulatory design and performance standards, material availability, cost effectiveness, current surface barrier technology information, and site-specific hydrologic and physical performance requirements to ensure waste containment and to inhibit human and biotic intrusion if necessary. The selected engineered barrier will be monitored to evaluate its performance. This performance monitoring (e.g., moisture monitoring within the engineered barrier) will allow for corrective measures (e.g., cap thickening) to be planned and implemented before any increased impact to the environment. The engineered barrier alternative includes provisions for groundwater monitoring for those waste sites with contamination predicted to impact groundwater. Institutional controls (e.g., deed restrictions, land-use zoning, and excavation permits) will be required to minimize the potential for exposure to contamination or compromising the effectiveness of the engineered barrier. It will be necessary to maintain institutional controls for 150 years or longer to ensure that human and biological intruders do not breach the barriers to create pathways for contamination.

SUMMARY OF ALTERNATIVE EVALUATIONS AND PREFERRED ALTERNATIVES

CERCLA Evaluation Criteria and Process

The Tri-Parties expect the preferred alternative to satisfy the following statutory requirements of CERCLA, Subsection 121(b).

- Be protective of human health and the environment.
- Comply with potential ARARs.
- Be cost-effective.
- Use permanent solution and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.
- Satisfy the preference for treatment as a principal element.

The EPA has developed nine CERCLA criteria to address statutory requirements and the technical and policy considerations important for selecting remedial alternatives. The nine CERCLA criteria, listed below, serve as the basis for conducting detailed and comparative analyses of the alternatives and for the subsequent selection of appropriate remedial actions:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability

- Cost
- State acceptance
- Community acceptance.

The nine CERCLA criteria are further organized into three criteria groupings—Threshold, Balancing, and Modifying. Each of the three criteria groupings is discussed below as implemented through the nine CERCLA criteria.

Threshold criteria are those that must be met. Any alternative that does not meet these criteria is eliminated from further consideration.

- *Overall Protection of Human Health and the Environment* is the primary objective of the remedial action and addresses whether a remedial action provides adequate overall protection of human health and the environment. This criterion must be met for a remedial alternative to be eligible for consideration.
- *Compliance with ARARs* addresses whether a remedial action will meet all of the ARARs and other Federal and state environmental statutes, or provides grounds for invoking a waiver of the requirements. This criterion must be met for a remedial alternative to be eligible for consideration.

Balancing criteria are used to weigh trade-offs among alternatives and are the basis for preferred alternative selection.

- *Long-Term Effectiveness and Permanence* refers to the magnitude of residual risk and the ability of a remedial action to maintain long-term reliable protection of human health and the environment after remedial goals have been met.
- *Reduction of Toxicity, Mobility, or Volume through Treatment* refers to an evaluation of the anticipated performance of the treatment technologies that may be employed in a remedy. Reduction of toxicity, mobility, and/or volume contributes toward overall protectiveness.
- *Short-Term Effectiveness* refers to the speed at which the remedy achieves protection. It also refers to the health and safety impacts to remediation workers and physical, biological, and cultural impacts that might result from construction and implementation of the remedial action.
- *Implementability* refers to the technical and administrative feasibility of a remedial action, including the availability of materials and services needed to implement the selected solution.
- *Cost* refers to an evaluation of the capital, operation and maintenance, and monitoring costs for each alternative. Discounted or present-worth costs are used as a means to compare costs for different alternatives that may be implemented over long periods of time.

Modifying criteria are used to refine remedy selection. Community acceptance of a preferred alternative can be determined only following the public comment period.

- *State Acceptance* considers the issues and concerns of the State of Washington, as represented by Ecology, with the preferred alternative, based on review of the Feasibility Study (DOE/RL-2005-63) and this Plan.
- *Community Acceptance* assesses the general public response to this Plan, following a review of the public comments received during the public comment period and open community meetings. The remedial action is selected only after consideration of this criterion.

Overall protection of human health and the environment and compliance with ARARs generally will serve as the threshold determinations in that they must be met by any alternative in order for it to be eligible for selection.

NEPA Values

NEPA values will be evaluated as part of DOE's responsibility. NEPA and its implementing regulations (DOE O 451.1B, *National Environmental Policy Act Compliance Program;* DOE, 2002, *DOE Policies on Application of NEPA to CERCLA and RCRA Cleanup Actions;* and DOE guidance for decommissioning [DOE G 430.1-4, *Decommissioning Implementation Guide*]) require that NEPA values be incorporated into decisions and documents as part of the CERCLA process. These values include, but are not limited to, cumulative, ecological, cultural, historical, and socioeconomic impacts and irreversible and irretrievable statements in lieu of preparing separate NEPA documentation. The impacts of these aspects of the human environment usually are not addressed otherwise within the CERCLA process. This integration provides a more comprehensive analysis of potential impacts resulting from the proposed 200-CS-1 OU cleanup activities. To support the CERCLA decision-making process, NEPA value analysis will be addressed in the resulting CERCLA decisions.

Remedial Alternatives

This section presents a detailed analysis of the alternatives evaluated under an industrial (exclusive) land-use scenario. Detailed evaluations were performed at the 216-A-29 Ditch, 216-B-63 Trench, 216-S-10 Ditch, and 216-S-10 Pond. Data obtained at the representative site (216-S-10 Pond) were used to evaluate the analogous site (216-S-11 Pond). The evaluation includes a description of how the alternative performed against the nine CERCLA criteria and a rationale for selection of the preferred alternative. Four remedial alternatives were developed for evaluation:

- **Alternative 1, No Action**
- **Alternative 2, MESC/MNA/IC**
- **Alternative 3, RTD**
- **Alternative 4, Engineered Barrier.**

Because CERCLA requires the evaluation of a "no-action" alternative as a baseline for comparison to other alternatives, this alternative is evaluated for all waste sites. Given that the Central Plateau is expected to support waste management for the foreseeable future, the evaluations use an industrial-exposure scenario. Analysis of the alternatives takes into account the nature of the contaminants at each site and the assumed land use. Currently, land use for the 200 Areas is industrial in nature, associated with the management of waste. This land use reasonably can be predicted to be the same for the next 50 years, given the DOE's current commitment to vitrify waste in the tank farms.

Waste Site 216-A-29 Ditch

The 216-A-29 Ditch is the longest of all the waste sites, approximately 6,500 ft (1.2 mi) in length. For the purposes of this analysis, the 216-A-29 Ditch was divided into segments to aid in the evaluation of alternatives. The 216-A-29 Ditch is divided into two segments as follows: Segment 1 extends from Test Pit AD-2 to Test Pit AD-3 and is approximately 4,920 ft (0.9 mi) in length; and Segment 2 extends from Test Pit AD-3 to Test Pit AD-1 and is approximately 1,580 ft (0.3 mi) in length (see Figure 4-1 of the Feasibility Study [DOE/RL-2005-63]). Based on the results of the risk assessment, groundwater protection pathway COCs and ecological receptor COPECs are present at Segment 2 at the 216-A-29 Ditch. For the evaluation of the remedial action alternatives, the COCs and COPECs present at the deepest depths for this waste site were selected as the risk drivers for the remedial action alternatives. The risk drivers for Segment 2 of the 216-A-29 Ditch include Aroclor-1254[1], 1,2 Dichloroethane, Benzo(a)anthracene, Bis (2-ethylhexyl) phthalate, Cadmium, Chrysene, Silver, Tetrachloroethylene, and

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[1] Aroclor is an expired trademark.

tributyl phosphate. No COCs or COPECs were identified as risk drivers for Segment 1 that would require a remedial action.

216-A-29 Ditch—Alternative Evaluations

The no-action alternative (Alternative 1) at the 216-A-29 Ditch would provide overall protection of human health because no COCs were identified from the direct contact exposure pathway under the industrial-exposure scenario. However, the no-action alternative is not protective of ecological receptors or the groundwater protection pathway at Segment 2. A screening-level ecological risk assessment was performed to identify COPECs, which suggests the potential for adverse ecological health effects. Under the no-action alternative, COCs are predicted to reach the groundwater at levels greater than maximum contaminant levels or are greater than WAC 173-340-747 groundwater protection cleanup levels; therefore, the no-action alternative would not provide long-term effectiveness and permanence for groundwater protection at Segment 2. Therefore, this alternative would not meet the ARARs identified for this waste site at Segment 2. As a result, the no-action alternative does not meet the threshold criteria; therefore, no further evaluation of the balancing criteria is needed to eliminate this alternative as a final remedial decision for Segment 2 at the 216-A-29 Ditch. Risk analysis of Segment 1 showed that no human health or groundwater protection pathway COCs and ecological receptor COPECs are present in this segment that require a remedial action. Therefore, the no-action alternative meets the threshold criteria for Segment 1 and no further action is justified.

Under the MESC/MNA/IC alternative (Alternative 2), existing soil covers would be maintained to provide protection from intrusion by human and/or ecological receptors. A minimum soil cover of 4.6 m (15 ft) is required to provide a sufficient obstacle to be protective of human and/or ecological receptors. Existing soil covers at the 216-A-29 Ditch are approximately 1 m (3 ft) thick and do not meet this thickness requirement to be protective. As a result, this alternative would not meet the ARARs identified for this waste site. In addition, the MESC/MNA/IC alternative would not provide long-term effectiveness because COCs at Segment 2 are predicted to reach the groundwater at levels greater than maximum contaminant levels or are greater than WAC 173-340-747 groundwater protection cleanup levels. Thus, the MESC/MNA/IC does not meet the threshold criteria; therefore, no further evaluation of the balancing criteria is needed to eliminate this alternative as a final remedial decision for Segment 2 at the 216-A-29 Ditch.

In the RTD alternative (Alternative 3), removal of the contaminated soil would provide overall protection of human health and the environment by eliminating the risk to the groundwater protection pathway and ecological receptors because contamination above cleanup levels occurs only in the shallow zone (<4.6 m [15 ft]). The 216-A-29 Ditch is divided into segments because only one of the segments will require soil removal. As discussed previously, the COCs and COPECs present at the deepest depths for this waste site were selected as the risk drivers. The following summarizes the depths of contamination at each of the segments based on the COCs and COPECs present.

- **Segment 1.** Risk analysis of Segment 1 showed that no human health or groundwater protection pathway COCs and ecological receptor COPECs are present in this segment that require remedial action. Therefore, removal of soil from this segment is not justified.

- **Segment 2.** Risk analysis of Segment 2 showed that COCs and COPECs in excess of the groundwater protection pathway and ecological receptor protection criteria extend to a maximum depth of approximately 2.6 m (8.5 ft).

Removing the contaminated materials from Segment 2 and using uncontaminated soils to backfill the excavations, contaminants would be minimized and/or eliminated to the extent necessary to protect human health and the environment. Included in this activity would be the need for borrow material for backfill. The 216-A-29 Ditch will require 1,100 m^3 (1,440 yd^3) additional backfill to bring the low areas level with the surrounding topography. The low areas are due to the terraces built during the last work performed at the site. In addition, the RTD alternative does achieve the next threshold criteria by complying with ARARs. This alternative meets the long-term effectiveness and permanence criterion because it removes the contaminants from the vadose zone and eliminates the potential risk to groundwater protection pathways and ecological receptors. No specific treatment has been identified for contaminated soils from the 216-A-29 Ditch, but movement of the waste to an approved disposal facility is expected to result in reduction of mobility and protection against remobilization of contaminants over their current location. The levels of contamination in the 216-A-29 Ditch do not pose a significant dose threat to industrial workers.

The surface area disturbed during excavation and construction activities at the 216-A-29 Ditch for Segment 2 will be approximately 0.5 ha (1.2 acres). Design activities and remediation would take approximately 5 months and remove approximately 7,230 m^3 (9,453 yd^3) of contaminated soil from Segment 2. Once completed, all long-term RAOs will be met, protecting groundwater and reducing risk to ecological receptors. The total project cost for implementation of the RTD alternative at Segment 2 of the 216-A-29 Ditch is $2,300,000. Details of the cost estimates are presented in Appendix H of the Feasibility Study (DOE/RL-2005-63).

In the engineered barrier alternative (Alternative 4), placement of an engineered barrier or cap system would break potential exposure pathways to human and ecological receptors and would be protective of human health and the environment. The cap would limit migration of COCs to the groundwater and provide additional distance between potential ecological receptors beyond the existing soil cover. A more detailed analysis of overall protection and barrier/cap size for each segment is presented below.

- **Segment 1.** Risk analysis of Segment 1 showed that no human health or groundwater protection pathway COCs and ecological receptor COPECs are present in this segment that require remedial action. Therefore, the use of an engineered barrier for this segment is not justified.
- **Segment 2.** There are no human-health COCs associated with Segment 2. However, risk analysis of Segment 2 showed that contamination above ecological receptor and groundwater protection criteria is present. Therefore, the use of an engineered ET Monofill Barrier would be appropriate and would provide overall protection. The estimated capping dimensions for this segment of the 216-A-29 Ditch include an approximate length of 550 m (1,652 ft) and a width of 26 m (85 ft).

This alternative would comply with all ARARs and would be protective of human health and the environment by breaking the pathways for human and ecological receptor exposure and emplacing caps that meet the intent of the regulations. In addition, this alternative would meet the long-term effectiveness and permanence criterion by reducing the ability of COCs to move from the shallow zone to the groundwater and by physically separating COPECs from ecological receptors. In this alternative, the engineered ET Monofill Barrier cover would extend beyond the estimated extent of soil contamination at Segment 2 of the 216-A-29 Ditch on all sides to ensure that contaminated soil is adequately covered. Reduction of toxicity, mobility, or volume through treatment will be achieved by substantially reducing the moisture movement through the waste site and, as a result, reducing the mobility of contaminants through the vadose zone. For this alternative, only moderate short-term risks are expected. The capping alternative would not require excavation of contaminated soils, so the risks to industrial workers primarily would be associated with general construction activities at the borrow sites and placement of the cap. Short-term impacts to vegetation and animals at this site would be low. This alternative is considered readily implementable.

Remedial design and construction of the cap for this waste site would take approximately 5 months with a final cap area of approximately 1.29 ha (3.2 acres) for Segment 2. The total project cost for Segment 2 at the 216-A-29 Ditch is $4,300,000 and includes placement of the ET Monofill Barrier and at least 150 years of long-term operations and maintenance consisting of site inspection/surveillance, periodic radiation site surveys of surface soil, biotic control, maintenance of signs and markers, cover maintenance, and site reviews. Details of the cost estimates are presented in Appendix H of the Feasibility Study (DOE/RL-2005-63).

216-A-29 Ditch—Preferred Alternatives Selection Rationale

The preferred alternative for Segment 2 at the 216-A-29 Ditch is Alternative 3, RTD, to mitigate risks associated with contaminants that are greater than cleanup levels for protection of groundwater pathway and ecological receptors. Risk analysis of Segment 1 showed that no human health or groundwater protection pathway COCs and ecological receptor COPECs are present in this segment that require a remedial action. Therefore, removal of soil from this segment or placement of an engineered barrier is not justified. The no-action and MESC/MNA/IC alternatives do not meet threshold criteria for overall protection of human health and the environment or compliance with ARARs for Segment 2. In addition, these two alternatives would not achieve Central Plateau, 200 Areas RAOs 1 through 4 for Segment 2 at the 216-A-29 Ditch. The RTD alternative will provide the same level of protection to the groundwater pathway and ecological receptors as the capping alternative because the excavated material will be disposed of in ERDF, an approved land disposal facility that also will be protected by an engineered surface barrier. The RTD alternative provides long-term effectiveness and permanence of the remedy equivalent to the capping alternative. Excavation to the depth of the contaminants at this site (<4.6 m [15 ft]) is readily achievable with minimal risk to remediation workers. The RTD alternative also is the most cost-effective of the alternatives that meet the threshold criteria for Segment 2. Table 6 summarizes the analysis of alternatives supporting the selection of the preferred alternatives.

Table 6. Comparison of Alternatives for the 216-A-29 Ditch.

CERCLA Criteria for Evaluation	Alternatives			
	① No Action	② MESC/MNA/IC	③ RTD	④ Engineered Barrier
216-A-29 Ditch	☑ **Segment 1**		☑ **Segment 2**	
Threshold Criteria				
Overall protection	☑	☐	☑	☑
Compliance with ARARs	☑	☐	☑	☑
Balancing Criteria				
Long-term effectiveness	N/A	N/A	◆	◆
Short-term effectiveness	N/A	N/A	◈	◈
Reduction in toxicity, mobility, or volume	N/A	N/A	◆	◆
Implementability	N/A	N/A	◈	◈
Cost				
Capital costs	$0	N/A	$2,300,000	$1,600,000
Non-discounted costs	$0	N/A	$2,300,000	$14,000,000
Total present worth	$0	N/A	$2,300,000	$4,300,000

The choice of the preferred alternative is based on information in DOE/RL-2005-63, *Feasibility Study for the 200-CS-1 Chemical Sewer Group Operable Unit*, and this Plan and may be revised if new information becomes available.

☑ = Indicates the preferred alternative.
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: partially satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
IC = institutional controls.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
N/A = not applicable.
RTD = removal, treatment, and disposal.

Waste Site 216-B-63 Trench

The 216-B-63 Trench is approximately 427 m (1,400 ft) in length. Based on the risk assessment and the condition of the soil covers as they currently exist, no COCs or COPECs were identified at the 216-B-63 Trench that require remedial action. However, additional RESidual RADioactivity (RESRAD) dose modeling was performed for the 216-B-63 Trench using the same input parameters used for the risk assessment, except the soil cover was removed and was not included in the model, to evaluate the risk to industrial workers from radiological contaminants (DOE Order 5400.5, *Radiation Protection of the Public and the Environment*) present at this site. Based on the results of the additional RESRAD modeling, a dose risk was present for industrial workers for the next 150 years at the 216-B-63 Trench. Therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained for at least 150 years to protect industrial workers.

216-B-63 Trench—Alternative Evaluations

The no-action alternative (Alternative 1) at the 216-B-63 Trench would not provide overall protection of human health and the environment because the existing soil cover will degrade and, based on RESRAD modeling, assuming that no soil cover exists, radiological contaminants would pose an unacceptable risk to industrial workers. Thus, this alternative does not provide long-term effectiveness based on the results of the RESRAD modeling. A dose risk was present for industrial workers for the next 150 years assuming no cover was present at the 216-B-63 Trench; therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained for at least 150 years to protect industrial workers. Reduction of toxicity, mobility, or volume through treatment would occur at this waste site in the form of natural attenuation. The radioactive decay process would influence some of the contaminants identified during characterization.

Based on the risk assessment, there would be no short-term risks to the public or industrial workers and no impact on the environment from this alternative because remedial activities would not be conducted. The no-action alternative could be implemented immediately and would not present any technical problems. This alternative would involve no direct cost because there will be no activities for this alternative at the site.

Under the MESC/MNA/IC alternative (Alternative 2), existing soil cover would be maintained to provide protection from intrusion by human and/or ecological receptors. Several ARARs were identified as applicable to this alternative and were evaluated. However, these ARARs are not applicable to this site, which has no human health and groundwater protection pathway COCs and no ecological receptor COPECs requiring remedial action. This alternative would provide long-term effectiveness based on the results of the additional RESRAD modeling. A dose risk was present for industrial workers for the next 150 years assuming no cover was present at the 216-B-63 Trench; therefore, it was determined that the soil cover on the 216-B-63 Trench needs to be maintained for at least 150 years to protect industrial workers. Similar to the no-action alternative, reduction of toxicity, mobility, or volume through treatment would occur at this waste site in the form of natural attenuation. For this alternative, only minimal short-term worker risks are expected, and these risks are associated with monitoring and maintenance activities. This alternative would not adversely impact the environment during construction and implementation because monitoring and maintenance activities are similar to existing institutional controls that are routinely implemented on site.

The total project cost is $1,000,000 for the 216-B-63 Trench and includes at least 150 years of periodic surveillance for evidence of contamination and ecological intrusion; emplacement of vegetation, herbicide application, or other activities to control deep-rooted plants; control of deep-burrowing animals; maintenance of signs and/or fencing; maintenance of the existing soil cover (including an assumed periodic addition of soil); administrative controls; and site reviews. Cost estimates for this alternative were developed based on existing costs for similar activities currently conducted on the Hanford Site. Details of the cost estimates are presented in Appendix H of the Feasibility Study (DOE/RL-2005-63).

Under the RTD alternative (Alternative 3), contaminated soil and debris (e.g., concrete or pipe associated with the sites) would be removed, treated as necessary to meet disposal facility waste acceptance criteria, and transported for disposal at an approved waste disposal facility. Because there are no human health or groundwater protection pathway COCs and ecological receptor COPECs at the 216-B-63 Trench requiring remedial action, removal of soil from this site is not justified.

Alternative 4, Engineered Barrier, uses engineered barriers or caps to (1) cover the contaminated waste sites; (2) control the amount of water that infiltrates into the contaminated media as a means of protecting groundwater; (3) prevent intrusion by human and ecological receptors as a means of protecting human health and the environment; and (4) limit wind and water erosion. The type of engineered barrier or cap used for a waste site is dependent on the risks present at the site. Because there are no human health or groundwater protection pathway COCs and ecological receptor COPECs at the 216-B-63 Trench requiring remedial action, the use of an engineered barrier for this waste site is not justified.

216-B-63 Trench—Preferred Alternative Selection Rationale

The preferred alternative for the 216-B-63 Trench is Alternative 2, MESC/MNA/IC, to mitigate dose risks present for industrial workers for the next 150 years. The no-action alternative does not meet threshold criteria for overall protection of human health and the environment or compliance with ARARs. The no-action alternative would not provide long-term maintenance of the existing soil cover at the trench; therefore, it would not achieve Central Plateau, 200 Areas RAO 2. In comparison, the MESC/MNA/IC alternative would achieve Central Plateau, 200 Areas RAO 2 by providing long-term maintenance of the existing soil cover at the trench. Central Plateau, 200 Areas RAOs 1, 3, and 4 are not applicable to this site because nonradiological COCs and groundwater COCs at this waste site do not justify a remedial action. Because there are no human health or groundwater protection pathway COCs and ecological receptor COPECs at the 216-B-63 Trench that require remedial action, removal of soil from this site or placement of an engineered barrier is not justified. The MESC/MNA/IC alternative also is the most cost-effective of the alternatives that meet the threshold criteria. Table 7 summarizes the analysis of alternatives supporting the selection of the preferred alternative.

Table 7. Comparison of Alternatives for the 216-B-63 Trench. (2 Pages)

CERCLA Criteria for Evaluation	Alternatives			
	① No Action	② MESC/MNA/IC	③ RTD	④ Engineered Barrier
216-B-63 Trench		☑		
Threshold Criteria				
Overall protection	☐	☑	N/A	N/A
Compliance with ARARs	☐	☑	N/A	N/A
Balancing Criteria				
Long-term effectiveness	☐	◆	N/A	N/A
Short-term effectiveness	◈	◆	N/A	N/A
Reduction in toxicity, mobility, or volume	◇	◆	N/A	N/A
Implementability	◆	◆	N/A	N/A
Cost				
Capital costs	$0	$35,000	N/A	N/A
Non-discounted costs	$0	$4,800,000	N/A	N/A
Total present worth	$0	$1,000,000	N/A	N/A
The choice of the preferred alternative is based on information in DOE/RL-2005-63, *Feasibility Study for the 200-CS-1 Chemical Sewer Group Operable Unit*, and this Plan and may be revised if new information becomes available in the future.				

Table 7. Comparison of Alternatives for the 216-B-63 Trench. (2 Pages)

CERCLA Criteria for Evaluation	Alternatives			
	① No Action	② MESC/MNA/IC	③ RTD	④ Engineered Barrier

☑ = Indicates the preferred alternative.	ARAR = applicable or relevant and appropriate requirement.
☑ = Yes, meets criterion.	CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
☐ = No, does not meet criterion.	MESC = maintain existing soil cover.
◆ = High: best satisfies evaluation guidelines.	MNA = monitored natural attenuation.
◈ = Moderate: partially satisfies evaluation guidelines.	IC = institutional controls.
◇ = Low: least satisfies evaluation guidelines.	N/A = not applicable.
	RTD = removal, treatment, and disposal.

Waste Site 216-S-10 Ditch

For the purposes of this analysis, the 216-S-10 Ditch is divided into three segments to aid in the evaluation of alternatives: the Covered Portion of the ditch extends from Test Pit SP-1 to Test Pit SD-1; Segment 1 extends from Test Pit SD-1 to Test Pit SD-3; and Segment 2 extends from Test Pit SD-3 to Test Pit SD-2 (see Figure 4-2 of the Feasibility Study [DOE/RL-2005-63]). Segment 1 and Segment 2 do not currently have a clean soil cover.

Based on the results of the risk assessment, groundwater protection pathway COCs and ecological receptor COPECs are present at Segment 2 of the 216-S-10 Ditch. For the evaluation of the remedial action alternatives, the COCs and COPECs present at the deepest depths for this segment were selected as the risk drivers for the remedial action alternatives. The risk drivers for Segment 2 at the 216-S-10 Ditch include Aroclor-1254, Chromium (total), Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, and silver. No COCs or COPECs were identified as risk drivers for the Covered Portion and Segment 1 that would require a remedial action.

Waste Site 216-S-10 Ditch Alternative Evaluations

The no-action alternative (Alternative 1) at the 216-S-10 Ditch would provide overall protection of human health because no COCs were identified from the direct-contact exposure pathway under the industrial-exposure scenario. However, the no-action alternative is not protective of ecological receptors or the groundwater protection pathway at Segment 2. A screening-level ecological risk assessment was performed to identify COPECs, which suggests the potential for adverse ecological health effects. Under the no-action alternative, COCs are predicted to reach the groundwater at levels greater than maximum contaminant levels or are greater than WAC 173-340-747 groundwater protection cleanup levels; therefore, the no-action alternative would not provide long-term effectiveness and permanence for groundwater protection at Segment 2. Therefore, this alternative would not meet the ARARs identified for this waste site. As a result, the no-action alternative does not meet the threshold criteria so no further evaluation of the balancing criteria is needed to eliminate this alternative as a final remedial decision for Segment 2 at the 216-S-10 Ditch. Risk analysis of the Covered Portion and Segment 1 showed that no human health or groundwater protection pathway COCs and ecological receptor COPECs are present in these segments that require a remedial action. Therefore, this alternative meets the threshold criteria for the Covered Portion and Segment 1 and no further action is justified.

Under the MESC/MNA/IC alternative (Alternative 2), existing soil covers would be maintained to provide protection from intrusion by human and/or ecological receptors. A minimum soil cover of 4.6 m (15 ft) is required to provide a sufficient obstacle to be protective of human and/or ecological receptors. Existing soil covers at the 216-S-10 Ditch are approximately 1 m (3 ft) thick and do not meet this thickness requirement to be protective. As a result, this alternative would not meet the ARARs identified for this waste site. In addition, the MESC/MNA/IC alternative would not provide long-term effectiveness because COCs at Segment 2 are predicted to reach the groundwater at levels greater than maximum contaminant levels or are greater than WAC 173-340-747 groundwater protection cleanup levels. Thus, the MESC/MNA/IC does not meet the threshold criteria so no further evaluation of the balancing criteria is needed to eliminate this alternative as a final remedial decision for Segment 2 at the 216-S-10 Ditch.

In the RTD alternative (Alternative 3), removal of the contaminated soil would provide overall protection of human health and the environment by eliminating the risk to the groundwater protection pathway and ecological receptors because contamination above cleanup levels occurs only in the shallow zone (<4.6 m [15 ft]). The 216-S-10 Ditch is discussed in segments because only some of the segments will require soil removal. As discussed previously, the COCs and COPECs present at the deepest depths for this waste site were selected as the risk drivers. The following summarizes the depths of contamination at each of the segments based on the COCs and COPECs present.

- **Covered Portion.** Risk analysis of the Covered Portion showed no human health or groundwater protection pathway COCs and ecological receptor COPECs are present in this segment that require remedial action. Therefore, removal of soil from this segment is not justified.
- **Segment 1.** Risk analysis of Segment 1 showed that no human health or groundwater protection pathway COCs and ecological receptor COPECs are present in this segment that require remedial action. Therefore, removal of soil from this segment is not justified.
- **Segment 2.** Risk analysis of Segment 2 showed that contaminants in excess of the ecological receptor and groundwater protection criteria extend to a maximum depth of approximately 0.9 m (3 ft).

By removing the contaminated materials from Segment 2 and using uncontaminated soils to backfill the excavations, contaminants would be minimized and/or eliminated to the extent necessary to meet ecological receptor and groundwater protection pathway cleanup levels. Thus, overall protection of human health and the environment threshold criteria would be achieved and exposure pathways to contaminants would be controlled. In addition, the RTD alternative does achieve the threshold criteria by complying with ARARs. This alternative meets the long-term effectiveness and permanence criterion because it removes the contaminants from the vadose zone and eliminates the potential risk to groundwater protection pathways and ecological receptors. No specific treatment has been identified for contaminated soils from the 216-S-10 Ditch, but movement of the waste to an approved disposal facility is expected to result in reduction of mobility and protection against remobilization of contaminants over their current location. The levels of contamination in the 216-S-10 Ditch do not pose a significant dose threat to industrial workers.

The surface area disturbed during excavation and construction activities at Segment 2 will be approximately 0.5 ha (1.2 acres). Design activities and remediation would take approximately 2 months and remove approximately 12,230 m^3 (15,996 yd^3) of contaminated soil. Once completed, all long-term RAOs will be met, protecting groundwater and reducing risk to ecological receptors. The total project cost for implementation of the RTD alternative at the 216-S-10 Ditch is $2,300,000. Details of the cost estimates are presented in Appendix H of the Feasibility Study (DOE/RL-2005-63).

In the engineered barrier alternative (Alternative 4), placement of an engineered barrier or cap system would break potential exposure pathways to human and ecological receptors and would be protective of human health and the environment. The cap would limit migration of COCs to the groundwater and provide additional distance between potential ecological receptors beyond the existing soil cover. A more detailed analysis of overall protection and barrier/cap size for each segment is presented below.

- **Covered Portion.** Risk analysis of the Covered Portion showed no human health or groundwater protection pathway COCs and ecological receptor COPECs are present in this segment that require remedial action. Therefore, the use of an engineered barrier for this segment is not justified.

- **Segment 1.** Risk analysis of Segment 1 showed that no human health or groundwater protection pathway COCs and ecological receptor COPECs are present in this segment that require remedial action. Therefore, the use of an engineered barrier for this segment is not justified.
- **Segment 2.** There are no human health COCs associated with Segment 2. However, risk analysis of Segment 2 showed that contamination above groundwater protection pathway and ecological receptor protection criteria is present. Therefore, the use of an engineered ET Monofill Barrier would be appropriate and would provide overall protection. The estimated capping dimensions for this site include an approximate length of 320 m (1,049 ft) and a width of 26 m (85 ft).

This alternative would comply with all ARARs and would be protective of human health and the environment by breaking the pathways for human and ecological receptor exposure and emplacing caps that meet the intent of the regulations. In addition, this alternative would meet the long-term effectiveness and permanence criterion by reducing the ability of COCs to move from the shallow zone to the groundwater and by physically separating COPECs from ecological receptors. In this alternative, the engineered ET Monofill Barrier cover would extend beyond the estimated extent of soil contamination at Segment 2 of the 216-S-10 Ditch on all sides to ensure that contaminated soil is adequately covered. Reduction of toxicity, mobility, or volume through treatment would be achieved by substantially reducing the moisture movement through the waste site and, as a result, reducing the mobility of contaminants through the vadose zone. For this alternative, only moderate short-term risks are expected. The capping alternative would not require excavation of contaminated soils, so the risks to industrial workers primarily would be associated with general construction activities at the borrow sites and placement of the cap. Short-term impacts to vegetation and animals at this site would be low. This alternative is considered readily implementable.

Remedial design and construction of the cap for this waste site would take approximately 2 months with a final cap area of approximately 0.81 ha (2 acres) for Segment 2. The total project cost for the 216-S-10 Ditch is $2,900,000 and includes placement of the engineered ET Monofill Barrier and at least 150 years of long-term operations and maintenance consisting of site inspection/surveillance, periodic radiation site surveys of surface soil, biotic control, maintenance of signs and markers, cover maintenance, and site reviews. Details of the cost estimates are presented in Appendix H of the Feasibility Study (DOE/RL-2005-63).

216-S-10 Ditch—Preferred Alternative Selection Rationale

The preferred alternative for Segment 2 of the 216-S-10 Ditch is Alternative 3, RTD, to mitigate risks associated with contaminants that are greater than cleanup levels for protection of groundwater pathway and ecological receptors. Risk analysis of the Covered Portion and Segment 1 showed that no human health or groundwater protection pathway COCs and ecological receptor COPECs are present in these segments that require remedial action. Therefore, removal of soil from these segments or placement of an engineered barrier is not justified. The no-action and MESC/MNA/IC alternatives do not meet threshold criteria for overall protection of human health and the environment or compliance with ARARs for Segment 2. In addition, these two alternatives also would not achieve Central Plateau, 200 Areas RAOs 1 and 3. Central Plateau, 200 Areas RAOs 2 and 4 are not applicable to this waste site because radiological contaminants are not present that require remedial action. The RTD alternative will provide the same level of protection to the groundwater pathway and ecological receptors as the capping alternative because the excavated material will be disposed of in ERDF, an approved land disposal facility that also will be protected by an engineered surface barrier. The RTD alternative provides long-term effectiveness and permanence of the remedy equivalent to the capping alternative. Excavation to the depth of the contaminants at this site (<4.6 m [15 ft]) is readily achievable with minimal risk to remediation workers. The RTD alternative also is the most cost-effective of the alternatives that meet the threshold criteria for Segment 2. Table 8 summarizes the analysis of alternatives supporting the selection of the preferred alternative for Segment 2.

Table 8. Comparison of Alternatives for the 216-S-10 Ditch.

CERCLA Criteria for Evaluation	Alternatives			
	① No Action	② MESC/MNA/IC	③ RTD	④ Engineered Barrier
216-S-10 Ditch	☑ Covered Portion, Segment 1		☑ Segment 2	
Threshold Criteria				
Overall protection	☑	☐	☑	☑
Compliance with ARARs	☑	☐	☑	☑
Balancing Criteria				
Long-term effectiveness	N/A	N/A	◆	◆
Short-term effectiveness	N/A	N/A	◈	◈
Reduction in toxicity, mobility, or volume	N/A	N/A	◆	◆
Implementability	N/A	N/A	◈	◈
Cost				
Capital costs	$0	N/A	$2,300,000	$1,300,000
Non-discounted costs	$0	N/A	$4,500,000	$16,000,000
Total present worth	$0	N/A	$2,300,000	$2,900,000

The choice of the preferred alternative is based on information in DOE/RL-2005-63, *Feasibility Study for the 200-CS-1 Chemical Sewer Group Operable Unit*, and this Plan and may be revised if new information becomes available in the future.

☑ = Indicates the preferred alternative.
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: partially satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
IC = institutional controls.
RTD = removal, treatment, and disposal.

Representative Waste Site 216-S-10 Pond and Analogous Site 216-S-11 Pond

Based on the risk assessment and the condition of the soil covers as they currently exist, no COCs or COPECs were identified at the 216-S-10 and 216-S-11 Ponds that require remedial action. However, additional RESRAD modeling was performed for the 216-S-10 and 216-S-11 Ponds using the same input parameters used for the risk assessment, except the soil cover was removed and was not included in the model, to evaluate the risk to industrial workers from radiological contaminants (DOE Order 5400.5) present at these sites. The RESRAD modeling for the 216-S-10 Pond and its analogous site (216-S-11 Pond) demonstrated that the soil cover is not needed to protect industrial workers.

216-S-10/216-S-11 Ponds—Alternatives Evaluation

The no-action alternative (Alternative 1) at the 216-S-10 and 216-S-11 Ponds would provide overall protection of human health and the groundwater pathway because no COCs were identified from the risk assessment that require remedial action. In addition, the no-action alternative is protective of ecological receptors because no COPECs were identified in the screening-level ecological risk assessment that require remedial action. Several ARARs were identified as applicable to the no-action alternative and were evaluated. However, these ARARs are not applicable to this site, which has no human health or groundwater protection pathway COCs and no ecological receptor COPECs that require remedial action. Therefore, this alternative meets both threshold criteria of overall protection of human health and the environment, and compliance with ARARs. RESRAD modeling for the 216-S-10 Pond and its analogous site (216-S-11 Pond) demonstrated that the soil cover is not needed to protect industrial workers from radiological contaminants present at these sites. Therefore, the no-action alternative for the 216-S-10 and 216-S-11 Ponds meets the long-term effectiveness balancing criterion under CERCLA.

Reduction of toxicity, mobility, or volume through treatment would occur at these waste sites in the form of natural attenuation. There would be no short-term risks to the public or workers and no impact on the environment from the no-action alternative because remedial activities would not be conducted. This alternative meets the short-term effectiveness balancing criterion under CERCLA. This alternative could be implemented immediately and would not present any technical problems. In addition, the no-action alternative would involve no direct cost because there will be no activities for this alternative at these sites.

Under the MESC/MNA/IC alternative (Alternative 2), existing soil cover would be maintained to provide protection from intrusion by human and/or ecological receptors. Several ARARs were identified as applicable to this alternative and were evaluated. However, these ARARs are not applicable to these sites, which have no human health or groundwater protection pathway COCs and ecological receptor COPECs that require remedial action. This alternative does provide long-term effectiveness based on the results of the additional RESRAD modeling. The RESRAD modeling for the 216-S-10 Pond and its analogous site (216-S-11 Pond) demonstrated that the soil cover is not needed to protect industrial workers from radiological contaminants present at these sites. Therefore, this alternative for the 216-S-10 and 216-S-11 Ponds meets the long-term effectiveness balancing criterion under CERCLA. For this alternative, only minimal short-term worker risks are expected, and these risks are associated with monitoring and maintenance activities. This alternative would not adversely impact the environment during construction and implementation because monitoring and maintenance activities are similar to existing institutional controls that are routinely implemented. This alternative meets the short-term effectiveness criterion under CERCLA for the 216-S-10 and 216-S-11 Ponds.

At the 216-S-10 and 216-S-11 Ponds, the MESC/MNA/IC alternative would provide overall protection of human health and the environment. The total project cost is approximately $0. Cost estimates for this alternative were not developed based on the threshold criterion for the no-action alternative being met.

Under the RTD alternative (Alternative 3), contaminated soil and debris (e.g., concrete or pipe associated with the sites) would be removed, treated as necessary to meet disposal facility waste acceptance criteria, and transported for disposal at an approved waste disposal facility. Because there are no human health or groundwater protection pathway COCs and ecological receptor COPECs at the 216-S-10 and 216-S-11 Ponds that require remedial action, removal of soil from these waste sites is not justified.

Alternative 4, Engineered Barrier, uses engineered barriers or caps to (1) cover the contaminated waste sites, (2) control the amount of water that infiltrates into the contaminated media as a means of protecting groundwater, (3) prevent intrusion by human and ecological receptors as a means of protecting human health and the environment, and (4) limit wind and water erosion. The type of engineered barrier or cap used for a waste site is dependent on the risks present at the site. Because there are no human health or groundwater protection pathway COCs and ecological receptor COPECs at the 216-S-10 and 216-S-11 Ponds that require remedial action, the use of an engineered barrier for these waste sites is not justified.

216-S-10/216-S-11 Ponds—Preferred Alternative Selection Rationale

The preferred alternative for the representative site 216-S-10 Pond and analogous site 216-S-11 Pond is Alternative 4, No Action. The no-action alternative meets the threshold criteria for overall protection of human health and the environment. In addition, the no-action alternative would comply with all ARARs for both the waste sites. The no-action alternative for the 216-S-10 and 216-S-11 Ponds is implemented easily. Tables 9 and 10 summarize the analysis of alternatives supporting the selection of the preferred alternative.

Table 9. Comparison of Alternatives for the 216-S-10 Pond.

CERCLA Criteria for Evaluation	Alternatives			
	① No Action	② MESC/MNA/IC	③ RTD	④ Engineered Barrier
Representative Site 216-S-10 Pond	☑			
Threshold Criteria				
Overall protection	☑	☑	N/A	N/A
Compliance with ARARs	☑	☑	N/A	N/A
Balancing Criteria				
Long-term effectiveness	◈	◈	N/A	N/A
Short-term effectiveness	◈	◈	N/A	N/A
Reduction in toxicity, mobility, or volume	◈	◈	N/A	N/A
Implementability	◆	◈	N/A	N/A
Cost				
Capital costs	$0	N/A	N/A	N/A
Non-discounted costs	$0	$0	N/A	N/A
Total present worth	$0	$0	N/A	N/A

The choice of the preferred alternative is based on information in DOE/RL-2005-63, *Feasibility Study for the 200-CS-1 Chemical Sewer Group Operable Unit*, and this Plan and may be revised if new information becomes available in the future.

☑ = Indicates the preferred alternative.
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: partially satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
IC = institutional controls.
N/A = not applicable.
RTD = removal, treatment, and disposal.

Table 10. Comparison of Alternatives for the 216-11 Pond. (2 Pages)

CERCLA Criteria for Evaluation	Alternatives			
	① No Action	② MESC/MNA/IC	③ RTD	④ Engineered Barrier
Analogous Site 216-S-11 Pond	☑			
Threshold Criteria				
Overall protection	☑	☑	N/A	N/A
Compliance with ARARs	☑	☑	N/A	N/A
Balancing Criteria				
Long-term effectiveness	◈	◈	N/A	N/A
Reduction in toxicity, mobility, or volume	◈	◈	N/A	N/A
Short-term effectiveness	◈	◈	N/A	N/A
Implementability	◆	◈	N/A	N/A

Table 10. Comparison of Alternatives for the 216-11 Pond. (2 Pages)

CERCLA Criteria for Evaluation	Alternatives			
	① No Action	② MESC/MNA/IC	③ RTD	④ Engineered Barrier
Cost				
Capital costs	$0	N/A	N/A	N/A
Non-discounted costs	$0	$0	N/A	N/A
Total present worth	$0	$0	N/A	N/A

The choice of the preferred alternative is based on information in DOE/RL-2005-63, *Feasibility Study for the 200-CS-1 Chemical Sewer Group Operable Unit*. The preferred alternative may be revised based on future characterization efforts at the analogous sites.

☑ = Indicates the preferred alternative.
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
IC = institutional controls.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
N/A = not applicable.
RTD = removal, treatment, and disposal.

Summary of Alternatives Evaluation

The range of potential alternatives for the 200-CS-1 OU were evaluated to determine their ability to protect human health and the environment. The preferred alternatives for the waste sites are as follows:

- **216-A-29 Ditch.** Alternative 1, No Action (Segment 1) and Alternative 3, RTD (Segment 2).
- **216-B-63 Trench.** Alternative 2, MESC/MNA/IC.
- **216-S-10 Ditch.** Alternative 1, No Action (Covered Portion and Segment 1) and Alternative 3, RTD (Segment 2).
- **Representative site 216-S-10 Pond and analogous site 216-S-11 Pond.** Alternative 1, No Action.

Based on information currently available, the Tri-Parties believe the preferred alternatives described above meet the threshold criteria and provide the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The risk analysis and alternatives evaluation show the preferred alternatives satisfy the following statutory requirements of CERCLA Subsection 121(b).

- Be protective of human health and the environment.
- Comply with ARARs.
- Be cost-effective.
- Use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.
- Satisfy the preference for treatment as a principal element.

PLUG-IN FOR FUTURE 200-CS-1 OPERABLE UNIT SOIL WASTE SITES

The plug-in approach is a process that will help the Tri-Parties make remedial action decisions for waste sites that have not been addressed in this Plan, using these existing CERCLA evaluations. The Tri-Parties propose that the plug-in approach be used in future remedy decisions for three types of waste sites:

- Unknown waste sites similar to those evaluated in this Plan that are discovered in the future
- Known waste sites that could be reassigned from another OU
- Confirmatory sampling that indicates variations from the defined CSM such that the selected alternative is no longer protective and a different alternative must be selected.

The benefit of a plug-in approach is to expeditiously clean up waste sites within the Central Plateau. The traditional CERCLA approach for remedy selection requires the development of many proposed plans and RODs. The proposed plug-in approach would allow analyses, evaluations, and selection of preferred alternatives identified in the Feasibility Study (DOE/RL-2005-63) and this Plan to be applied to similar waste sites. Building off existing work allows remedial actions to begin earlier and streamlines a costly and often redundant remedy selection process. While the likelihood is slight that this approach will be used to plug-in waste sites to the 200-CS-1 OU, the concept and process are explained below.

Three elements/criteria are required to successfully use a plug-in approach:

- **Establish the Conceptual Model.** Multiple analogous waste sites must be identified that share common physical and contaminant characteristics. These characteristics are known as the CSM.
- **Establish the Standard Remedy.** A remedial (cleanup) alternative, or standard remedy, must be established that has been shown to be protective and cost-effective for sites that share the common CSM.
- **Establish Need for Remedial Action.** Sites sharing a common CSM must be shown to require remedial action because of contaminant concentrations that pose a risk to human health and the environment.

To use the plug-in approach for a waste site not evaluated in the Feasibility Study (DOE/RL-2005-63), the site must fit the defined conceptual model and must be shown to require remedial action. The site then can be "plugged in" to the standard remedy. The following section describes how the plug-in approach would be used for remedy selection.

Establishing the Conceptual Site Model

Two CSMs were defined, based on the following site characteristics:

- Type of contaminant at the waste site (e.g., radionuclides, nonradionuclides)
- Concentration of contaminant at the waste site
- Types of contaminated environmental media (e.g., soil) or material (e.g., concrete, metal, wood)
- Extent of contamination within the environment (i.e., the depth of discharge, the expected contaminant distributions [both lateral and vertical], and the potential for contaminant to impact groundwater).

Based on the representative sites evaluated in the Feasibility Study (DOE/RL-2005-63), the following CSMs were developed.

- The CSM for "Human Health," Figure 3-3 in the Feasibility Study (DOE/RL-2005-63), was formulated according to standards provided in specific sections of EPA and WAC 173-340, "Model Toxics Control Act - Cleanup," guidance. Using this guidance, professional judgment, and current understanding of site conditions, the conceptual model identified contaminant sources, release mechanisms, routes of migration, potential exposure points, potential routes of exposure, and potential population groups associated with the 200-CS-1 OU.
- The "Ecological Exposures (Industrial Land-use)" CSM, Figure 3-5 in the Feasibility Study (DOE/RL-2005-63), provides a current understanding of the sources of contamination, physical setting, ecological habitat, receptors of concern, and current and future land use, and identifies

potentially complete ecological exposure pathways for the study area. Information generated during the remedial investigation process was incorporated into this CSM to identify potential exposure scenarios. The CSM addresses exposures that could result under current site conditions and from reasonably anticipated potential future uses for the site and the surrounding areas.

Establishing the Need for Remedial Action

Waste sites that share a common CSM will "plug in" to the standard remedy if it is determined that remedial action is required because of the risk to human health and the environment. The risks for newly discovered waste sites will be evaluated following data evaluation. Remedial action will be required for sites that contain radioactive contaminants that are greater than the RAOs. For sites that are not greater than these criteria, no further action is proposed.

Public Involvement in the Plug-in Approach

To ensure that the public is involved meaningfully when the plug-in approach is used, the Tri-Parties propose to publish these post-ROD changes as explanations of significant differences (ESD), consistent with EPA guidance. The ESD includes a 30-day public comment period. The ESD must describe the nature of the significant changes, summarize the information that leads to making the changes, and affirm that the revised remedy complies with CERCLA and 40 CFR 300 (including ARARs).

These post-ROD changes will be evaluated at the following points in the plug-in process:

- When newly discovered waste sites are proven through sampling and analysis to be above remediation goals and can plug in to a standard remedy
- When confirmatory sampling indicates variations from the defined CSM such that the selected alternative is no longer protective and a different standard remedy must be selected.

RCRA TREATMENT, STORAGE, AND/OR DISPOSAL UNIT CLOSURE PERFORMANCE STANDARDS AND CLOSURE STRATEGY

The RCRA TSD units within the 200-CS-1 OU include the 216-A-29 Ditch, the 216-B-63 Trench, and the 216-S-10 Pond and Ditch (two waste sites are combined into one TSD unit). These TSD units will undergo closure following the requirements of the Tri-Party Agreement (Ecology et al., 1989a); WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8, for the Treatment, Storage, and Disposal of Dangerous Waste*; and WAC 173-303-610. Characterization sampling of these TSD units occurred in conjunction with the CERCLA remedial action investigation for the 200-CS-1 OU.

The closure approach for a TSD unit will be based on characterization results coupled with the remedy chosen under this Plan. As a preferred approach to closure, clean closure will be evaluated. If data do not support clean closure, landfill closure will be pursued. In some cases, clean closure of soils and structures can be accomplished, while groundwater monitoring proceeds into post-closure.

PUBLIC PARTICIPATION

Public Involvement

Tribal nations, stakeholders, and the public are encouraged to review and provide comments on this Plan during the 45-day public comment period that runs from TBD through TBD.

Public Meeting

If requested, a public meeting will be held to answer questions and take comments. To request a public meeting, contact John Price before TBD. The public meeting will be held during the public comment period and will be announced in the *Tri-City Herald*.

Submitting Comments

The Tri-Parties will accept written comments on this Plan from TBD through TBD. Comments should be sent to John Price at the Washington State Department of Ecology via:

- mail: ATTN: Mr. John Price, 3100 Port of Benton Blvd., Richland, WA 99354-1670
- fax: (509) 372-7971
- email: jpri461@ecy.wa.gov

Hanford Public Information Repository Locations

Copies of this Plan are available at the Hanford Public Information Repositories located at the University of Washington in Seattle, Washington; Gonzaga University in Spokane, Washington; Portland State University in Portland, Oregon; and Washington State University in Richland, Washington.

This Plan also is available electronically at http://www.hanford.gov/public/calendar/ under the Public Comment Period section.

The Administrative Record also contains copies of this Plan and supporting documents. The Administrative Record is located at 2440 Stevens Center Place, Room 1101; Richland, Washington 99352. This information can be accessed electronically at http://www2.hanford.gov/arpir.

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